DALLAS/FORT WORTH INTERNATIONAL AIRPORT
DESIGN, CODE AND CONSTRUCTION DEPARTMENT

ADDENDUM NO. 4
FOR

REHABILITATE EAST & WEST POTABLE WATER STORAGE TANKS

CONTRACT NO. 9500547

August 18, 2017

The Request for Bids for the above is hereby revised as follows:

Technical Specifications Revisions

1. Section 09 90 00, page 16, Replace Table No. 1 with table below:

TABLE NO. 1

TANK INTERIOR				
COATING SYSTEM	**MANUFACTURER**	**PRIMER COAT**	**INTERMEDIATE COAT**	**FINISH COAT**
Inside coating system No. 3	Tnemec	94-H20 Hydro-Zinc		Series 22- WH07 or Series FC22 Epoxoline
	Raven	AquaPrime primer		Aquatapoxy A-6
	Sherwin-Williams	**Corothane1 – Galvapac Zinc**		**Sherplate PW Epoxy B62-260 Series**
	Carboline	**Carboguard 61**		**Carboline Phenoline 341**
Inside coating system No. 5	Tnemec	94-H20 Hydro-Zinc	Series 20- Pota-Pox	Series 20- Pota-Pox
	Sherwin Williams	Corothane1 –Galvapac Zinc NSF	Macropoxy 646W Epoxy B58-600	Macropoxy 646W Epoxy B58-600
	Indurion	Indurazinc MC67	PE-70 or RC-70	PE-70 or RC-70
	Carboline	**Carboguard 891 VOC**	**Carboguard 891 VOC**	**Carboguard 891 VOC**

2. Section 26 42 00 Cathodic Protection, dated 12 June 2015 is hereby replaced with attached Section 26 42 50 Cathodic Protection – Impressed Current, dated 18 August 2017.

3. Section 26 42 80 Cathodic Protection for Existing Tank Bottoms, dated 18 August 2017, is hereby added to the project's Technical Specifications.

4. Section 00 01 10 Table of Contents, dated 17 February 2017, is hereby replaced with attached Section 00 01 10 dated 18 August 2017.

5. Section 13 33 00 Welded Steel Tanks Roof Replacement, dated 17 February 2017, is hereby replaced with attached Section 13 33 00 dated 18 August 2017.

6. Section 43 45 13 Inspection Welded Steel Tanks, dated 17 February 2017, is hereby replaced with attached Section 43 45 13 dated 18 August 2017.

Plan Sheet Revisions

1. N/A

Schedule Revisions

1. N/A

RFB Revisions

1. Appendix 6 – Bid Schedule has been revised as detailed below and replaced as posted on www.dfwairport.com/business/solicitations Bid schedule is revised to include the following changes:
   a. Revise bid item 14 specification number from 26 42 00-1 to 26 42 50-1
   b. Revise bid item 15 specification number from 26 42 00-2 to 26 42 80-1
   c. Insert bid item 31 specification number 05 50 00 Repair Level Gauge (one per tank), complete, for the east tanks.
   d. Renumber old bid items from 31-51 to 32-52.
   e. Revise old bid item 39 (new bid item 40) specification number from 26 42 00-1 to 26 42 50-1
   f. Revise old bid item 40 (new bid item 41) specification number from 26 42 00-2 to 26 42 80-1

Solicitation Questions (Q) and Answers (A)

1. (Q) – The tank shell thicknesses indicated in section 13 33 00 ¶ 1.5 table of tank element thickness for the 101'Ø west tanks are insufficient to meet either the requirements of Section 3 or Section 14 of AWWA D-100. Also using the thicknesses provided in this table requires stiffening of the tank shell for wind. Please provide accurate tank shell thickness information for these tanks.

   (A) – All information available is provided with the bid documents. See revised Section 43 45 13 for tanks shell plate thickness existing conditions basis.

2. (Q) – Section 43 41 13 paragraph 3.4.43 States that a seismic design for the roof framing and columns is required per AWWA D-100 section 13.5.4.5. AWWA D-100 section 13.5.4.5 requires that the Engineer to specify the live loads to be used for horizontal and vertical seismic design of the framing and the columns.

   (A) – The live load to be utilized per Section 13.5.4.5 is 40 lbs/ft^2.

3. (Q) – The thickness of the roof knuckle is not provided for either tank. This information will be required seismic design of the roof structure. We are requesting a confirmation of knuckle radius for each tank as well as knuckle thickness.

   (A) – See response #1 above.

4. (Q) – Tank bottom plate thickness is not provided in the inspection report in Appendix A. Please confirm thickness.

   (A) – See response #1 above.

5. (Q) – Drawings S-05 and S-08 do not show the dimension for the roof handrailing. In addition, the handrail details in the elevation and plan views of the tank do not line up. Please provide dimensional information on the handrailing.

(A) – East Pump Station tanks will require 180 linear feet of handrail per tank and West Pump Station tanks will require 140 linear feet of handrail per tank. Handrail detail on page S-12 do not line up because there is a ladder landing handrail interface. The ladder landing sits higher/on top of tank roof while the roof handrail is attached directly to the roof.

6. (Q) – Section 05 50 00 Metal Fabrications indicates that handrails can be galvanized steel. The tank drawings contain notes that the handrails are FRP. Please clarify the materials of construction for the handrail. If the handrails are to be FRP please provide a recommended vendor.

(A) – Handrail material shall be as depicted on the plans, FRP.

7. (Q) – Specification 26 42 00 does not work for the cathodic protection plans and details. The specification that was prepared originally for the CP details that were reused in this bid package would work with the only change being renaming from 16642 to 26 42 00.

(A) – See Technical Specifications Revision responses #2 & #3 above.

8. (Q) – Note 9 sheet E-02 and the symbol for reference electrodes does not match. There are three (3) symbols for reference electrodes and the note calls for four(4). Which is correct? This question does not apply to the EPS as the numbers match.

(A) – Four is correct.

9. (Q) – The details used for the tank internal system came from an old design prepared by Applied Corrosion Technology in the late 1990's. That design was a retrofit into the tanks replacing the original ICCP systems. The anode suspension system required a plate over the existing access holes due to the size of the hole. The deck mount only comes in one size. It is designed to fit an opening that is 3" - 3.25" in diameter. The total width of the deck mount is only 4.5" in diameter.

The original openings in the tank were 5" in diameter, thus a plate was required to reduce the opening size. Since the roof will be replaced, new openings will be required. These should be installed when the roof is placed.

(A) – Agreed, details for the corrosion protection to be submitted for approval during construction and coordinated with tank contractor.

10. (Q) – There are missing dimensions for the diameter of each of the three anode rings on the tanks. Those should be added to the drawings. In the original design for the East PS, they were 6' R, 31.5' R, and 61' R.

(A) – See Technical Specifications Revision response #2 which contains this information.

11. (Q) – Are the rectifiers to be coated or left galvanized. If coated, what color?

(A) – See Specification 26 24 50 attached herein.

12. (Q) – We are a manufacture of polyurea and we have contractors who would like to bid on this particular job. VersaFlex would appreciate the consideration of our AquaVers 405.

(A) – Substitution requests or new product requests will be evaluated on a case by case basis during shop drawing review and approval.

13. (Q) – Is this taxable or exempt?

(A) – Taxation questions should be directed to each Firm's own tax attorneys or advisors.

14. (Q) – Do the insurance requirements stated in the documents apply to subcontractors as well as general contractors?

(A) – Yes. As stated in Clause 3.0.C of the Special Provisions:
"The Contractor shall insert the substance of this Section 3.0 in subcontracts under this Contract, that require work on property owned or operated by, or under the control of, the OWNER and shall require subcontractors to provide and maintain the insurance required herein or the Contractor may provide said insurance coverage for the subcontractor(s). At least five (5) calendar days before entry of each such subcontractor's personnel on the installation, the subcontractor(s) shall furnish to the Contractor, a current certificate of insurance meeting the requirements of the Contract. The Contractor shall maintain a file of all such certificates on site and readily available for review by the OWNER or its authorized representative."

15. (Q) – Sherwin-Williams is providing coating systems for the interior and exterior coatings sections that meet/exceed the coatings listed in Table No. 1, inside Coatings SYS #3, Inside Coatings SYS #5, Outside Coating SYS #6 and the Filler section in the master bid document package. The only change being requested is to update to current products and add a Sherwin-Williams product to the No.3 Inside Coating product section. The Sherwin-Williams Sher-Plate PW meets/exceeds the Tnemec and Raven systems listed and was not included in Table #1 Inside Coatings System No.3

(A) – See Technical Specifications Revision response #1 above.

16. (Q) – Requesting Carboline's addition to the interior specification for systems 3 & 5, respectively:

System #5 - Ist Coat: Carboguard 891VOC applied @ 4-6 mils DFT; 2nd Coat: Carboguard 891VOC applied @ 4-6 mils DFT; 3rd Coat: Carboguard 891VOC applied @ 4-6 mils DFT.

System #3 - Primer: Carboguard 61 applied @ 4-6 mils DFT; and Finish: Carboline Phenoline 341 applied @ 20-25 mils DFT.

(A) – See Technical Specifications Revision response #1 above.

17. (Q) – Note 4 sheets E-01and E-02 call for manual controlled rectifiers. The rectifiers originally installed were auto-potential controlled units. Please confirm the type of rectifiers specified. Note, if an auto-potential controlled units are required, the reference electrode lead wires must either be shielded or contained in a separate conduit from the anode positive header cable.

(A) – See Technical Specification 26 42 50 attached herein. Existing rectifier and junction box for internal cathodic protection system shall be removed and replaced with new rectifier per Section 26 42 50 requirements.

18. (Q) – Can the existing header cable from the rectifiers to the anode junction boxes be abandoned place.

(A) – No, cable shall be removed.

19. (Q) – Detail 2 Sheet E-03 shows a welded plate over a 5" diameter opening in the roof top. This detail was only applicable to retrofitting the insulating deckmount anode suspension system onto these tanks. The deckmount only requires a 3" diameter opening.

(A) – The diameter of the opening shall be determined by cathodic protection supplier and coordinated with General Contractor installing roof replacement during shop drawing review.

20. (Q) – Does this project have a “domestic only” material clause? Are there any specifically excluded countries?

(A) – No.

21. (Q) – Can the max crane height be clarified as the elevation 60 feet (or more if possible) above the tank foundations?

(A) – The maximum crane height for all locations is 60-feet. The Contractor shall comply with the requirements set forth in FAA Advisory Circular 150/5370-2, latest edition, “Operational Safety on Airport During Construction, and Chapters 3, 4, 5, and 12 of Advisory Circular 70/7460-1, latest edition, “Obstruction Marking and Lighting”. The Contractor may request a greater height to the Owner for approval of the 7460 by the FAA at least 60 days prior to commencing work at said work area.

22. (Q) – Will “daily” hot-work permits be required to be picked up prior to starting any hot-work?

(A) – According to specification 01 11 00, section 1.6E, the Contractor shall obtain a permit from the DFW Department of Public Safety for all hot work activities. Daily hot-work permits are not required.

23. (Q) – What other airport construction activities are scheduled to commence at the tanks location during our contract period?

(A) – For both the east and west tanks, there may be a project to provide modifications inside the pump stations. No other improvements are known at this time. Refer to specification 01 14 16 for additional coordination requirements.

24. (Q) – Section 43 45 13 describes the need for an API 653 tank inspection on the other three tanks. There is no apparent line item for pricing on the other three tanks. Is this section omitted from the bid or should it be added to the bid schedule?

(A) – Per Section 43 45 13, Part 4 Measurement and Payment, payment for this item is incidental to tank roof replacement.

25. (Q) – TNEMEC requested on letter dated July 20, 2017 to evaluate new paint systems (interior and exterior) and/or modify specifications to already approved systems.

(A) – Substitution requests or new product requests will be evaluated on a case by case basis during shop drawing review and approval.

26. (Q) – To count for the 5% goal required for this project, a subcontractor must be certified MBE. DBE or WBE will not count, is that correct?

(A) – We will only accept MBE certificates. All other certificates will not be acceptable (i.e. WBE, DBE, HUB, etc.)

27. (Q) – Our bonding company needs clarification on the warranty requirements. The following is a list of warranty periods found in the specifications. Are these durations indeed the requirement for each area? It's very unusual to see varying warranty periods and durations as long as these. Is a warranty bond or maintenance bond required for these durations? Bonding companies will not bond durations of these lengths.

a. Tank repairs and coatings: 10 yrs
b. Panel boards: 5 yrs
c. Cathodic protection: 15 yrs
d. Water mixer: 5 yrs

(A) – Refer to Section 01 78 33 Warranties and Bonds for more information. Also, refer to revised Section 13 33 00 Welded Steel Tanks Roof Replacement as well as new cathodic protection Section 26 42 50 Cathodic Protection Induced Current and Section 26 42 80 Cathodic Protection Existing Tank Bottoms for updated warranty information. All other warranty durations within the specifications remain unchanged.

SECTION 26 24 50

CATHODIC PROTECTION – IMPRESSED CURRENT

PART 1 - GENERAL

1.1 SCOPE

A. The work consists of furnishing all labor, materials, equipment and services required or necessary for corrosion control in accordance with the design specifications and details shown on the Contract Drawings.

B. The work includes, but is not limited to, the removal of existing cathodic protection equipment, installation of cathodic protection equipment.

C. Metalwork consists of furnishing all labor, equipment, appliances and materials, and in performing all operations for the installation of miscellaneous metalwork complete in strict accordance with this Section of the Specifications and the Contract Drawings and subject to the terms and conditions of the contract. The work includes, but is not limited to, furnishing all materials and labor for mountings of electrical components, fabrication and mounting of fittings, anode access holes, hangers and other miscellaneous metal required under this Section of the Specifications. All anode holes shall be coordinated with roof installation.

D. Electrical work consists of furnishing all labor, equipment, appliances and materials, and in performing all operations necessary for the electrical work complete in strict accordance with this Section of the Specifications and the Contract Drawings and subject to the terms and conditions of the Contract. The work includes, but is not limited to, all cutting, channeling and closing necessary for installation of wiring systems, conduits, rectifiers, impressed current anodes, furnishing all materials, fixtures, fittings and devices called for in these Specifications and on the Contract Drawings.

E. All material in contact with water or exposed to the interior of the tank are to be classified in accordance with ANSI/NSF 61, “Drinking Water System Components”.

1.2 RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

A. Section 09 90 00: Protective Coatings

B. Division 26: Electrical

1.3 QUALITY ASSURANCE

A. All labor, installation, wiring and equipment must comply, in full, with the standards or regulations of:

1. Airport Building Code
2. National Electric Code (N.E.C.)
3. National Electrical Manufacturer's Association (N.E.M.A.)
4. Underwriter's Laboratories, Inc. (U.L.)
5. Institute of Electrical and Electronic Engineers (I.E.E.E.)
6. Occupational Safety and Health Act (O.S.H.A.)
7. NACE International (NACE)

B. Whenever there is a conflict between requirements of this Specification, the Drawings, applicable Codes or Standards, the more stringent shall apply.

C. All Codes and Standards referenced in this Specification shall be current. Permission for deviation from this Specification and the reference Codes and Standards must be obtained in writing from the Owner’s Authorized Representative.

1.4 PERMITS AND LICENSES

A. The contractor shall procure all required permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work. The cost of such permits and licenses shall be included in the bid prices for the items of work performed under this section of the specifications. Separate or additional payment will not be made therefore.

1.5 WORKING DRAWINGS

A. The Contract Drawings indicate the arrangement of the equipment, wiring and fittings. The Contractor shall carefully examine these drawings and shall be responsible for the proper installation of materials and equipment in such locations as indicated, without substantial alteration. Working drawings indicating proposed departures due to actual field conditions or other causes shall be submitted to the Owner’s Authorized Representative for review and approval.

B. The approval of working drawings by the Owner’s Authorized Representative shall not relieve the Contractor of his responsibility to furnish all materials and perform all work required by the Contract Documents.

1.6 GUARANTEE

A. The system furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period of one year from the date of acceptance thereof either for beneficial use or final acceptance,

whichever is earlier. Upon notice from the Owner of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be replaced promptly with new parts by, and at the expense of, the Contractor.

1.7 STANDARD PRODUCTS

A. Unless otherwise indicated in writing by the Owner's Authorized Representative, the materials to be furnished under this Section of the Specifications shall be the standard product of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest approved standard design.

1.8 SUBMITTALS

A. Submit shop drawings or manufacturer's data in accordance with Section 01 33 23.

B. Design Drawings and Computations: Prepare all computations and drawings by or under the direct supervision of a Corrosion Engineer who is a Professional Engineer, registered in the State of Texas with a minimum of ten years experience in cathodic protection design for water storage tanks. Design the system to provide effective corrosion control in accordance with the criterion for protection which is tank-to-water potential, IR drop free, within a range of -0.850 volts to -1.050 volts relative to copper-copper sulfate reference electrode. Measure this potential free of the effect of voltage gradients (IR drops).

The Corrosion Engineer to base system capacity upon:

1. Total surface area of the tank. Total surface area includes to high water line in bowl and wet risers in elevated tanks, which are 30 inch diameter or larger.

2. High quality interior coating.

3. Protection of bare steel surfaces due to coating deterioration of up to 10% of total submerged surface area.

4. Chemical and electrical analysis of water including conductivity.

5. Minimum anode system life of twenty (20) years.

Provide certificate, signed and sealed by the Professional Engineer stating that computations and Drawings are in conformance with these design criteria.

C. Catalog Cuts: Submit manufacturer's catalog cuts for the system which demonstrates classification in accordance with ANSI/NSF 61 – Drinking Water System Components.

D. Rectifier Operation and Maintenance Manual: The rectifier manufacturer to include a complete operation and maintenance manual with each rectifier shipped to the job site. In addition to operating instructions, include in the manual a circuit diagram and spare parts list. Manufacturer to operate the rectifier under full load conditions at the factory, and thoroughly inspect and test prior to delivery to the job site. Report results of this testing on a manufacturer's quality control form and include in the rectifier operation and maintenance manual. Each operating manual to be identified by rectifier model number and individual serial number.

E. Operating and Maintenance Manual: Submit six (6) operating, monitoring and maintenance manuals for the cathodic protection system. Include operating instructions, maintenance data, product data and test procedures in the manuals.

F. Drawings: Maintain as-built drawings of the corrosion control system during installation and construction. Revise drawings to show exact locations of all wiring, connections and terminal boxes. Properly identify all items of equipment and material. Submit the original as-built drawings to the Owner's representative.

1.9 MATERIALS STANDARDS

A. Unless indicated or specified otherwise, installation, materials and equipment shall conform to the Specifications listed in applicable paragraphs.

1.10 EQUIPMENT

A. All equipment necessary for the satisfactory completion of all work under this Section of the Specifications shall be in first class working condition, be standard for the industry and be approved by the Owner's Authorized Representative before starting work. It shall be maintained in first class operating condition throughout its use on the project. Any equipment not approved by the Owner's Authorized Representative shall not be used. Any rejected equipment shall be removed from the site.

1.11 QUALIFICATIONS

A. A minimum of five years experience installing and servicing the types of system described in this specification is required for the Cathodic Protection Contractor. Install the system by employees of the Cathodic Protection Contractor who have experience in the installation of water tank systems. All personnel subject to Federal Substance Abuse and Testing Regulations that satisfy the requirements of DOT 199 equipment.

PART 2 - MATERIALS

2.1 ANODES

A. Anodes shall be of special alloy, high silicon chromium bearing cast iron. The anodes shall conform to the physical properties and chemical analyses below.

B. Physical Properties:

1. Tensile Strength (1/2 inch dia. bar), psi	15,000
2. Compressive Strength, psi	100,000
3. Hardness, Brinell	520
4. Density, gr/ml	7.0
5. Melting point, ^{o} F	2,300
6. Specific Resistance, micro-ohms/cm 20 ^{o} F	72
7. Coefficient of Expansion, 32 - 212 ^{o} F	7.33 x 10EXP-6

C. Chemical Analysis:

1. ELEMENT	PERCENT
a. Silicon	14.35
b. Carbon	0.85
c. Manganese	0.65
d. Chromium	4.5
e. Iron	Remainder

f. Individual anodes shall have a minimum weight of 1 lb and shall be equivalent to a Model 1F9 anode with caulked ends and epoxy seals on both ends.

D. Anode Ring Spacing

1. East Tank
   a. Ring No. 1 — 6.0-ft. from tank center
   b. Ring No. 2 — 31.5- ft. from tank center
   c. Ring No. 3 — 61-ft. from tank center

2. West Tank
   a. Ring No. 1 — 6ft-4in from tank center
   b. Ring No. 2 — 17- ft. from tank center
   c. Ring No. 3 — 38ft-6in. from tank center

E. Acceptable Manufacturers - Anotec Industries, LT LTD. 12294 - 104th Ave Surrey, B.C., Canada V3V 3H3 604-x83- 1794, or Owner Approved Equal.

2.2 ANODE LEAD WIRES

A. Anode lead wires shall be No. 8 AWG stranded copper with a HMWPE

insulation as shown on the Contract Drawings and shall be attached to the anode by the manufacturer with a cast epoxy-resin encapsulation to seal the anode-to-cable connection.

2.3 ANODE HEADER CABLE

A. All exposed cable shall be a No. 6 AWG stranded copper wire with HMWPE insulation, conform to the Underwriters Laboratories standard for polyethylene cable, and have the following specifications:

Specific Gravity	0.91 - 0.93
Tensile Strength, psi	1,400
min Elongation, %	400
min	
Heat Softening Point, ^{o}C	110
Brittleness Range, ^{o}C	-45 to -55
Dielectric Constant	2.3 - 2.8
Dielectric Strength, volts/mil	500

B. All cable enclosed within metallic conduit shall be a No. 6 AWG stranded copper wire with NFPA 70 type THW insulation or equal, black in color.

2.4 DECKMOUNTS

A. Deckmounts shall be insulating and self-sealing. They shall consist of a molded fiberglass product complete with a 1/8" thick neoprene-sealing gasket capable of supporting a minimum of 150 lbs. dead weight. They shall be configured as shown on the Contract Drawings.

B. Acceptable Manufacturer - Brance Krachy, Inc. 4411 Navigation Blvd. Houston, TX 77011 713/225-6661, or Owner Approved Equal.

2.5 WEIGHTS

A. Weights shall be shop fabricated using 24” of 2” SCH. 40 PVC pipe, with solvent welded caps at both ends, and filled with approximately 5-lbs. of washed sand.
   1. All caps shall be solvent welded to the pipe.

B. A ¼” x 2” SS eyebolt shall be attached to the top cap.

C. The entire assembly shall be suspended on a ¼” nylon rope attached to a Deckmount.

2.6 RECTIFIERS

A. Use air-cooled cathodic protection transformer-rectifiers with automatic potential control.

B. DC Output Ratings: Rate rectifiers as shown on the Drawings. Provide for continuous, full rated output at an ambient temperature of 45° C, in full sunlight with an expected life in excess of 10 years.

C. AC Input Ratings: Obtain full rated DC output with an AC input voltage at 5% below the nominal value. Continuous AC input voltage at 10% above the nominal value shall not damage the transformer, the diode bridge assembly, or exceed any component ratings. (Note: This applies provided that the rectifier has not been previously adjusted to exceed the maximum DC voltage or amperage rating of the unit.)

D. Cooling: Cool units by natural air convection. Vent cabinets for natural air convection and screen against insects.

E. Rectifying Elements: For rectifying elements, use silicon diodes sized as follows:

1. The Peak Inverse Voltage (PIV) of the diode to be 300% of the maximum impressed voltage on the diode or 400 volts, whichever is greater.

2. Configure diodes into a full-wave bridge assembly. Size diodes to carry an average current of no more than 55% of the manufacturer's recommended maximum current rating.

3. Size heat sinks to keep diode case temperatures less than 100° C at rated rectifier output and at maximum rated ambient temperature.

4. Protect diodes against overload by means of semiconductor fuses, located in the transformer secondary leg to the diode bridge assembly.

5. Equip diodes with supplemental Metal Oxide Varistor (M.O.V.) surge arrestors at the diode bridge assembly sized to provide protection against secondary over- voltage surges.

F. AC Circuit Breakers: Provide input overload and short circuit protection by magnetic trip circuit breakers. Size the circuit breaker to hold 100 percent of rated load. It may trip between 101 percent and 125 percent of rated load and must trip at 125 percent and above. This applies to all rectifiers with rated AC input currents greater than 4 amperes. For units rated below 4 amperes, use a 5 ampere rated circuit breaker.

G. Surge Protection: Provide separate AC and DC surge protection by means of high energy Metal Oxide Varistors rated at 500 joules on DC output and 1000 joules on the AC input.

H. Electrical Panels: Electrical panel minimum thickness is 0.187" NEMA Grade "XX" laminated phenolic, rated for Class "B" operation (105° C maximum). Equip rectifiers rated at 100 amperes DC or higher with panels constructed from a minimum sheet thickness of 1/4" "UTR" fiberglass reinforced laminate rated for Class "F" operation (155° C). Either permanently silk-screen onto

the panel, or use 1/16" lamicoid (plastic laminate) adhesive labels permanently engraved with white lettering on a black background, the rectifier instrument panel identifications. Mechanically affix the adhesive labels to the panel via stainless steel rivets or screws.

I. Connection Hardware: For all electrical hardware, use copper or high conductivity brass, suitably sized, and finished with electrolyses nickel plating for superior corrosion resistance. Tightly secure all connections with lock washers and nuts torqued to manufacturer's recommended specifications. For all electrical connections, use the "double nut" method to ensure that any compression of the panel material will not affect the electrical conductivity of the connection.

J. Enclosures:

1. Construct enclosures from a minimum 12 gauge, wiped coat mill galvanized steel, finished in 3 – 5 mils of polyester fusion bonded powder coating.

2. Use stainless steel hinges and cabinet assembly bolts.

3. Equip enclosures with a pad-lockable draw latch. Latch shall be manufactured from 12 gauge steel, finished in zinc-dichromate plating. Draw latch shall accommodate a 3/8 inch shackle padlock.

4. Equip enclosures with a grounding lug sized to accommodate up to a No. 6 AWG conductor.

5. Provide separate conduit knockouts for AC and DC; conveniently located and adequately sized for input and output conduit connectors.

6. Furnish cabinet with suitable channel brackets for wall or pole mounting.

7. Equip rectifier with slide-out chassis and hinged door, for access to the front and at least one side of the cabinet.

K. Automatic Controller: Use IR Drop Free automatic controller:

1. Automatic controller to adjust current output to compensate for changes in water level, temperature of water, water chemistry, and cathodic polarization.

2. Control from copper/copper sulfate reference electrodes with a minimum of two electrodes positioned in the tank. One cell is the operating cell and the other is for a back up and testing.

3. Reference electrodes to constantly monitor the tank-to-water potential, free of IR drop.

4. Automatic controller to automatically adjust the current output to maintain the tank-to-water potential, free of IR drop, to a preset value.

5. Operate within 25 mV of preset value.

6. Automatically limit current to a preset value.

7. Use a digital potential meter to display tank-to-water potential, free of IR drop.

L. Transformers: Transformers to conform to UL 506, Specialty Transformers and the following:

1. Isolation transformer designed with separate isolated primary and secondary windings with a minimum efficiency of 95%.

2. Equip transformer secondary with a minimum of 25 steps of secondary voltage adjustment (5-COARSE, 5-FINE). Use tap bars for tap adjustment.

3. Rate transformer materials and construction for Class "H" operation (180° C). Further enhance insulation materials by dipping in thermosetting varnish and baking.

4. Rate the transformer for a minimum dielectric strength of 2250 volts applied for one minute between the windings, and between the windings and the core.

M. Miscellaneous:

1. All rectifiers to operate with either a 115 or 230 volt, single phase, 60 hertz AC input.

2. Cathodic Protection Rectifier to be 100% quality control tested as outlined in this specification.

3. During manufacture, subject the rectifier to frequent visual and performance testing to ensure a high degree of quality.

4. Subject rectifiers to 100% testing of the following rectifier electrical parameters:

a. AC input voltage, current, apparent power and true power.

b. DC output current, voltage and power.

c. AC power factor.

d. AC to DC conversion efficiency.

e. Output ripple.

2.7 CONDUIT, FITTINGS AND PULL BOXES

A. Conduit for cathodic protection wiring shall be rigid aluminum conduit as

specified elsewhere and shall be of the size suitable for the use intended. Fittings, junction boxes, etc. shall be of the type and material shown on the Contract Drawings.

2.8 SPLICE KITS

A. Splice kits shall be comprised of a two part plastic enclosure, two part epoxy compound and rubber sealing tape.

2.9 STATIONARY REFERENCE ELECTRODES

A. Interior tank reference electrodes shall be copper/copper sulphate with a 20- year design life.

B. Reference lead wire shall be yellow #14 AWG, stranded copper with a NFPA Type 70 insulation, type RHW/USE. Lead wire length shall extend to the rectifier without splices.

C. Reference electrodes shall be suspended from the tank ceiling and shall be attached to the tank interior sidewall as shown in the contract documents.

D. The stationary reference electrode shall be equivalent to an Electrochemical Devices, Inc. Model IR-M-CUG-CW.

E. Acceptable Manufacturer - Electrochemical Devices, Inc., PO Box 355, Belmont, MA 02478-0003, Tel: 617-484-9085, Fax: 617-484-3923, or Owner Approved Equal

2.10 COPPER COMPRESSION CRIMPITS

A. All anode pigtail to anode positive header cable or positive header to positive header cable connections shall be made using a copper compression "C" crimpit appropriately sized for all wire connections.

2.11 WIRE AND CABLE MARKERS

A. All wire and cable shall be marked with cloth markers, split sleeve or tubing type markers.

2.12 SPARE PARTS

A. The rectifier shall include spare parts for the following components.
   1. Two complete sets of fuses
   2. One A.C. Input Lightning Arrestor
   3. One D.C. Output Lightning Arrestor
   4. One plug-in type solid state, printed circuit board for automatic control of the rectifier.

PART 3 - EXECUTION

3.1 IMPRESSED CURRENT SYSTEMS – GENERAL

A. The Cathodic Protection Contractor shall coordinate a set of approved tank fabrication drawings from the General Contractor prior to any submittals.

B. The Cathodic protection layout shall be modified to accommodate actual conditions. The cathodic protection system shall be installed at the location and in accordance with the details shown on the Contract Drawings.

C. The Owner's Authorized Representative will energize the cathodic protection system and conduct final tests after system installation and final filling of the tank.

D. All items shall be fabricated in accordance with the best shop methods. All accessories or metal items required to complete the installation, though not indicated in detail or specified, shall be provided under this Section. Bolts, nuts, washers and all other standard commercial fittings shall be hot dipped galvanized.

E. The Contractor may not enter the tank unless wearing approved clothing and footwear after the tank has been painted internally.

3.2 GENERAL INSTALLATION PROCEDURES

A. The Contractor shall install all anodes of the size and type indicated on the Contract Drawings at locations shown. This includes but is not limited to rectifiers, connecting cables, connections to the tank structure, or other wiring.

B. All rectifier mounting studs, anode hole closures, anode access holes and conduit supports shall be installed prior to painting tank internal surfaces in accordance with Contract Drawings.

C. Anode wires and header cables shall be handled in a such a way as to avoid damage to the insulation. Any cable, wire, splice, splice insulation, etc., deemed by the BOARD's representative to be damaged or of poor workmanship shall be rejected.

D. Before energizing the system, anode splices shall be inspected by the Owner's inspector.

3.3 TANK ANODE INSTALLATION

A. Anodes shall be handled with care. Impressed current anodes are extremely fragile. They shall not be thrown, dropped or rolled. Pulling on anode leads to place the anode connection under tension is prohibited. Any connections or seals which appear to be damaged shall not be used before consulting the supplier.

B. Each anode string shall be suspended from an individual tank Deckmount. The anode pigtail shall be connected to the Deckmount as shown on the Contract Drawings. Care shall be taken to prevent anode leads and connecting cables from contacting sharp edges of the tank anode access portal.

C. Improperly installed anodes shall be removed and replaced at the Contractor's expense.

3.4 ANODE DESIGN MODIFICATION

A. The contractor may submit an alternate design for this system including the anode material and rectifier sizing.

1. The alternate design shall be prepared by a licensed professional engineer in the State of Texas with active accreditation as a NACE Corrosion Specialist or Cathodic Protection Specialist.
   a. The alternate design submittals shall include all calculations for the anode configuration and rectifier sizing. The alternate design shall include scale layout drawings based upon the submitted tank fabrication drawings and shall be signed and sealed by the aforementioned engineer.
   b. The alternate design may be based upon either a horizontal or vertical anode configuration.
   c. If vertical, precious metal wire anodes are installed each anode assembly shall have a tank weight connected to the end of the supporting cable.
2. The alternate design shall be based upon a ten (10) year design life, maximum 15% bare wetted surface area, and a water resistivity of 3,000 ohm-cms. Icing conditions are not a consideration.

B. The design modifications shall be submitted in full to the Owner’s Authorized Representative for approval prior to fabrication.

3.5 RECTIFIER

A. The location, type and size or capacity of the rectifier shall be as shown on the Contract Drawings. The actual settings of voltage and amperage will be determined by the Owner’s Authorized Representative, who will by means of field tests, certify the results of the installed system.

B. Neutral conductors and non-current carrying parts of equipment at the rectifier installation shall be grounded. Ground conductors shall be connected to the existing grounding system.

C. The rectifier shall be mounted as indicated in the Contract Drawings. The Contractor shall furnish all materials, including hardware and fittings, for mounting the rectifier. All structural shapes and fittings shall be accurately fabricated in accordance with the Contract Drawings for mounting of

electrical components. Holes shall be accurate and true to dimension for mounting of the rectifier, in accordance with the best shop practice.

D. Each rectifier shall have its own fused switch in its AC supply line. This switch shall be contained in a separate enclose and mounted adjacent to the rectifier.

E. Negative lead connections shall be made in strict accordance with the details shown on the Contract Drawings. Particular care shall be taken to produce a clean metal surface on the area where the connection is to be made.

3.6 CABLE SPLICES

A. All taps from anodes strings to the common under-roof header cable shall be made using copper compression "C" crimpits made up using a mechanical compression tool equal to a Burndy MD6/8 with the appropriate dies and as shown on the Contract Drawings.
   1. Sufficient slack shall be left in the anode pigtail to allow easy removal of the anode string through the anode access hole.

B. All splices to the anode header cable shall be electrically insulated using a two-part epoxy splice kit, correctly sized for wire and crimpit size.
   1. The completed splice shall be kept immobile for a period of two hours after mixing and pouring the epoxy compound.

C. All splices shall be inspected by the BOARD's inspector prior to placing the splice inside the tank.

3.7 INSTALLATION OF ABOVE GROUND WIRING

A. Where conduit is exposed, runs of conduit shall have supports spaced not more than eight feet apart and shall be installed with runs parallel or perpendicular to walls, structural members or intersections of symmetrical bends. Bends and offsets shall be avoided where possible. Necessary bends shall be made with an approved conduit-bending machine. Crushed or deformed conduit shall not be installed.

B. Approved types or malleable iron zinc-coated beam clamps and conduit hangers shall be secured to the structure per the recommendations of the manufacturer. All runs of conduit shall be arranged so that no moisture traps are present. The Contractor shall exercise the necessary precautions to prevent dirt, concrete or trash from entering conduit fittings and boxes during the course of installation. Conduit shall be entirely free of these accumulations or shall be replaced.

C. Solderless pressure connectors, properly taped, shall be utilized for all above ground splices in wiring. Non-insulated connectors on A.C. conductors shall be wrapped with three layers of vinyl electrical tape.

3.8 REFERENCE ELECTRODE INSTALLATION

A. All reference electrodes shall be suspended from Deckmounts and attached to tank sidewalls as shown on contract documents.

B. The reference electrode lead wire shall be installed in conduit from the rectifier to the point wherein the wire enters the tank. This conduit shall not be used by anode or structure lead wires.

3.9 ANODE/REFERENCE ELECTRODE ACCESS HOLE

A. All access holes shall be installed prior to painting internal tank surfaces.

B. Anode access holes shall be mechanically cut with an industrial hole saw.

C. Contractor shall radius all sharp edges with a hand grinder and shall remove all traces of cutting oil prior to priming all bare steel areas.

D. All debris resulting from the cutting operation shall be removed from the interior tank floor before application of the coating system.

3.10 WIRE IDENTIFICATION

A. Provide wire or cable markers on each conductor at panel boards, junction boxes, load centers and rectifiers.

3.11 ENERGIZING THE SYSTEM

A. General: After the system is installed and the tank is filled, provide startup service which includes energizing, testing, and adjusting the system for optimum performance.

B. Notice: Prior to native state, polarized potential testing and commissioning of the system, give a minimum of 48 hours notice to the Owner.

C. Locks: In order to maintain the set parameters for the transformer-rectifier, install a hardened steel lock for the transformer-rectifier enclosure provided by the Owner. The external disconnect will be locked by the pump station Personnel.

D. Methods: Field test the system by conducting IR drop-free measurements. Measure “instant off” tank-to-electrolyte potentials to determine system performance and to adjust the system. Record all tank-to-water potential measurements with the permanent and with a calibrated, portable, copper-copper sulfate reference electrode and a portable high impedance voltmeter. Measure a minimum of five locations within the tank.

E. Reports: Review and evaluation of all test data is to be performed by the Corrosion Engineer. In addition to the startup service, submit “as-built” drawings and an Operations and Maintenance Manual to the Owner in accordance with Section 01 78 23.

PART 4 – MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

A. No direct measurement will be made for the material, equipment, or labor required by this item. Payment for the Work performed as well as the materials and equipment furnished under this item will be paid for each Cathodic Protection System. The Cathodic Protection Systems are either classified as Interior or Exterior. Payment shall be full compensation for all labor, tools, equipment, materials, repairs, time and incidentals necessary to complete work.

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SECTION 26 24 80
CATHODIC PROTECTION FOR EXISTING TANK BOTTOMS

PART 1 - GENERAL

1.1 SCOPE

A. Requirements for impressed current cathodic protection systems for the bottom (soil side) of steel water storage tanks that are constructed at grade level.

B. Specifications for manually controlled transformer-rectifiers and deep anodes.

1.2 RELATED SECTIONS

A. Section 26 24 50 – Cathodic Protection Impressed Current.

1.3 REFERENCES

A. ASTM C 94 - Ready Mixed Concrete.

B. ASTM D 1248 - Polyethylene Plastics Molding and Extrusion Material.

C. ASTM A 518 – Standard Specification for Corrosion-Resistant High-Silicon Iron Casting

D. ASTM D 4239 – Standard Test Methods for Sulfur in the Analysis Sample of Coal and Coke using High Temperature Tube Furnace Combustion Methods

E. ASTM D 5192 – Standard Practice for Collection of Coal Samples from Core

F. NEC 70 - National Electrical Code

G. NACE RP-0193 - External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms

H. NACE RP-0169 - Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems

I. NACE RP-0572 - Recommended Practice for Design, Installation, Operation and Maintenance of Impressed Current Deep Groundbeds

J. NEMA TC6 - PVC and ABS Plastic Utilities Duct for Underground Installation

K. NEMA TC9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation

L. NEMA 4 - Type 3R Enclosures

M. UL 83 - Thermoplastic-Insulated Wires

N. UL 467 - Bonding and Grounding Equipment

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

1.4 SUBMITTALS

A. General: Submittals to conform to the requirements of Section 01 33 23.

B. Design Drawings and Computations: Prepare by or under the direct supervision of a Corrosion Engineer who is a Professional Engineer, registered in the State of Texas with a minimum of ten years experience in cathodic protection design.

C. Catalog Cuts: Submit manufacturer's catalog cuts for each item. Include the manufacturer's name on the catalog cuts. Provide sufficient information to show that the materials meet the requirements of the drawings and specifications. Where more than one item or catalog number appears on a catalog cut, clearly identify the item proposed.

D. Logs: Give the Owner's representative a minimum of 48 hours notice prior to drilling the anode bore. Type and submit to the Owner's representative, copies of detailed geological and resistance logs of each deep anode bore.

E. Rectifier Operation and Maintenance Manual: The rectifier manufacturer to include a complete operation and maintenance manual with each rectifier shipped to the job site. In addition to operating instructions, include a circuit diagram and spare parts list in the manual. Operate the rectifier under full load conditions at the factory and thoroughly inspect and test by the manufacturer prior to delivery to the job site. Report results of this testing on a manufacturer's quality control form and include in the operation manual. The rectifier manufacturer to reference each operating manual by rectifier model number and individual serial number.

F. Operating and Maintenance Manual: Submit six (6) operating, monitoring and maintenance manuals for the cathodic protection systems. The manuals shall include operating instructions, maintenance data, product data and test procedures.

G. Drawings: Maintain as-built drawings of the corrosion control system during installation and construction. Revise drawings to show exact locations of all wiring, connections and terminal boxes. Properly identify all items of equipment and material. Submit the original as-built drawings to the Owner's representative.

1.5 QUALITY CONTROL

A. Certification: Provide manufacturer's certifications that all components of the cathodic protection systems meet the requirements of the drawings and specifications. Reference the applicable section of the specifications and the applicable standard details on the certification.

B. Drawings: The drawings for the cathodic protection systems are diagrammatic and not to be scaled for exact locations unless scales are explicitly stated on the specific drawing. Determine exact locations by field conditions and non-interference with other utilities or mechanical and structural features. Note other existing utilities in the area and do not damage these utilities during excavation.

Repair any damaged utilities to the satisfaction of the Owner at the Contractor's expense.

C. Inspection: All materials, fabrication and installations are subject to inspection and testing by the Owner or its designated representative.

1.6 GUARANTEE

A. The system furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period of one year from the date of acceptance thereof either for beneficial use or final acceptance, whichever is earlier. Upon notice from the Owner of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be replaced promptly with new parts by, and at the expense of, the Contractor.

PART 2 - PARTS

2.1 IMPRESSED CURRENT ANODES

A. Description: Use high silicon-chromium-iron anode centrifugally cast in tubular form in accordance with the following specifications.

1. Anode Alloy: The anode to consist of Durichlor 51, high silicon, chromium iron. This alloy to be made in accordance with specification ASTM A 518, Grade 3 with nominal percentages as follows:

Chemical Composition

Element	Composition, Weight %
Carbon	0.70 - 1.10
Manganese	1.50, max
Silicon	14.20 - 14.75
Chromium	3.25 - 5.00
Molybdenum	.20, max
Copper	0.50, max

2. Casting Method: Centrifugally cast anodes in tubular form with a hollow, straight walled design. Do not exceed greater than ¼" bowing and malformation tolerances over the seven foot anode length. Do not allow anode designs which include enlargement of the outside diameter, at the center or elsewhere, or constrictions of a venturi type of the inside.

The anode body to have solid walls of a uniform thickness with an open cylindrical interior. Do not allow static casting methods, such as sand, die or metal mold techniques, in order to avoid the risk of shrink cavities and internal stresses caused by non-uniform wall thickness.

Use of extraneous materials such as chaplets, spacers or chills, to center the anode mold are not to be permitted. Restrict any slag deficiencies to one end

of the casting only allowing for simple inspection techniques to ascertain metal density and absence of slag inclusions.

3. Mechanical and Physical Properties: The mechanical and physical properties of the anode are as follows:

Tensile Strength (1/2" dia. bar) psi	15,000
Compressive Strength, psi	100,000
Hardness, Brinell	520
Density, gr/ml	7.0
Melting Point, °F	2300
Specific Resistance, micro-ohms-cm (20°C)	72
Coefficient of expansion, 32° to 212° F	7.33×10^6

4. Size: Conform to the following sizes for anode castings:

Type	Weight (pounds)	O.D. (inches)	Length (feet)
TA-2	46	2.19	7
TA-3	63	2.66	7
TA-4	85	3.75	7
TA-5	110	4.75	7

TA-2 anodes are required unless otherwise noted on the drawings.

B. Anode Lead Wire Connection:

1. Use a No. 8 AWG seven strand, copper conductor equipped with fluorinated polymer insulation for the lead wire for an impressed current anode. Require the length of the lead wire sufficient to reach the anode terminal box without splicing additional wire.
2. Attach the anode lead wire at the center of the anode. Have a minimum pull-out strength of one and one-half times the breaking strength of the No. 8 AWG lead wire or 788 pounds for the center connection.
3. Do not exceed 0.004 ohms for the electrical contact resistance as measured across the lead wire-to-connector junction.

C. Anode Backfill: Use SC 3 calcined petroleum coke, as manufactured by Loresco Inc., to backfill impressed current anodes. Anode backfill shall conform to the following:

1. Typical Chemical Analysis.

Component	Percent Composition
Carbon (fixed)	99.35 minimum
Ash	0.6 maximum
Volatiles	0 (950 ° C)
Moisture	0.05

2. Physical Properties.

Bulk Density	64 pounds/cubic foot

3. Particle Analysis.

   Dust free with a maximum particle size of 1 mm.

2.2 VENT

A. Use plastic vent pipe from the bottom anode to the surface for dissipating gases to the atmosphere.

B. Provide 1-inch diameter pipe with 1/8-inch holes drilled on 6-inch centers in the area of the anodes for the vent. Do not drill holes in the vent pipe above the anodes.

C. Extend the plastic vent pipe above grade, screen the vent outlet, and install in an inverted manner.

2.3 RECTIFIERS

Cathodic protection rectifiers to be air-cooled, tap adjust Super Custom model as manufactured by Good-All Electric, Universal Rectifiers or approved equal, conforming to NEMA MR-20-1958 and listed in the CSA File No. 45382.

A. DC Output Ratings: Rate rectifiers at minimum 80 volts / 40 amps (East Tanks) and 60 volts / 30 amps (West Tanks). Supply units that are capable of operating at continuous, full rated output at an ambient temperature of 45° C, in full sunlight with an expected life in excess of 10 years.

B. AC Input Ratings: Obtain full rated DC output, with an input voltage $\pm$10 percent of the nominal rated input.

C. Cooling: Cool by natural air convection. Vent cabinets for natural air convection and screen against insects.

D. Voltage Adjustments: Provide adjustment of the output voltage by means of not less than 25 approximately equal steps of secondary taps from 5 percent of rated voltage to full-rated voltage.

E. Rectifying Elements: Rectifying elements to be silicon diodes sized as follows:
   1. Rate diode voltage at 400 volts minimum for rectifier outputs up to 100 VDC, and 800 volts minimum for rectifiers with outputs from 100 to 200 VDC.
   2. Configure diodes into a full-wave bridge assembly. Size diodes to carry a minimum average current of one half of rated rectifier output.
   3. Size heat sinks to keep diode junction temperatures less than 100° C at rated output and maximum ambient temperature.
   4. Protect diodes against overload by means of semiconductor fuses, located in the transformer secondary leg to the diode bridge assembly.
   5. Equip diodes with supplemental Metal Oxide Varistor (M.O.V.) surge arrestors at the diode bridge assembly sized to provide protection against secondary over-voltage surges.

F. AC Circuit Breakers: Provide input overload and short circuit protection by magnetic trip circuit breakers. Size the circuit breaker to hold 100 percent of rated load. It may trip between 101 percent and 125 percent of rated load and must trip at 125 percent and above.

G. Surge Protection: Provide separate AC and DC surge protection by means of high energy Metal Oxide Varistors rated at 500 joules on DC output and 750 joules on the AC output.

H. Electrical Panels: Construct electrical panels from a minimum thickness of 1/4" NEMA "XX" laminated phenolic, rated for Class "B" operation (105° C maximum). Equip rectifiers rated at 100 amperes DC or higher with panels constructed from a minimum sheet thickness of 1/4" "UTR" fiberglass reinforced laminate rated for Class "F" operation (155° C). Permanently silk-screen rectifier front panel identifications onto the panel.

I. Connection Hardware: Use only copper or high conductivity brass electrical hardware, suitably sized, and finished in electroless nickel plating for superior corrosion resistance. Tightly secure all connections with lock washers and nuts torqued to manufacturer's recommended specifications.

J. Enclosures:
   1. Construct enclosures from a minimum 12 gauge wiped coat mill galvanized steel, finished in 3 - 5 mils polyester fusion bonded powder coating.
   2. Use stainless steel hinges and cabinet assembly bolts.
   3. Equip enclosures with a pad-lockable draw latch manufactured from 12-gauge steel, finished in zinc-dichromate plating. A draw latch required to accommodate a 3/8 inch shackle padlock.
   4. Equip enclosures (or rectifier frame) with a grounding lug sized to accommodate up to a No. 6 AWG conductor.
   5. Provide separate conduit knockouts for AC and DC; conveniently located and adequately sized for input and output conduit connectors.
   6. Furnish cabinet with suitable channel brackets for wall or pole mounting.
   7. Equip rectifier with slide-out chassis and hinged door for access to the front and a minimum of one side of the cabinet.

K. Rectifier Instrumentation.
   1. Equip rectifier with separate analog ammeter and voltmeter.
   2. Meters to be a minimum of 3-1/2" size, with a minimum scale length of 2-7/8".
   3. Meters to be 0 - 50 millivolts full scale deflection, taut-band movement with four-to-one swamping (i.e. internal meter resistance comprised of 25% winding resistance and 75% fully temperature compensated dropping resistor for wide temperature range performance).
   4. Provide meters with accuracy $\pm$ 2% full scale deflection at 25° C., temperature compensated to 0.085% per degree C.
   5. Scale rectifier meters to have rated output no less than 70%, or greater than 85% of full scale deflection.
   6. Meter shunts to be panel-mounted Holloway type "SW" style, with an accuracy of $\pm$0.25%.

L. Transformers: Construct transformers to meet UL 506, Specialty Transformers and the following:

1. Transformer designed as full isolation with separate isolated primary and secondary windings with a minimum efficiency of 95%.
2. Equip transformer secondary with a minimum of 25 steps of secondary voltage adjustment (5-COARSE, 5-FINE). Provide tap adjustment by means of tap bars.
3. Rate transformer materials and construction for Class "H" operation (180° C). Further enhance insulation materials by dipping in thermosetting varnish and baking.
4. Rate transformer for a minimum dielectric strength of 2250 volts applied for one minute between the windings and the core.

M. Current Interrupters: Include a built-in current interrupter rated in accordance with the capacity of the rectifier unit. Equip the interrupter with a solid-state timer with independently adjustable "On" and "Off" times. Equip interrupter with a switch to enable the operator to operate the rectifier in an interrupt or continuous mode of output.

N. Miscellaneous:

1. Supply rectifiers capable of operating either on 115 or 230 volt, single phase, 60 hertz AC input.
2. All cathodic protection rectifiers to be 100% quality control tested as outlined in this specification.
3. During manufacture, subject the rectifier to frequent visual and performance testing to assure a high degree of quality.
4. Subject rectifiers to 100% testing of the following rectifier electrical parameters:
   a) AC input voltage, current, apparent power and true power.
   b) DC output current, voltage and power.
   c) AC power factor.
   d) AC to DC conversion efficiency.
   e) Output ripple.
   f) Correct operation of optional features such as interrupters, filters, etc.
5. Give each rectifier a final overall visual inspection prior to packaging.

2.4 DC CABLES

A. Cables: Use seven strand, copper conductors with high molecular weight polyethylene (HMWPE) insulation for the rectifier positive and negative cables.

2.5 THERMITE WELD EQUIPMENT

A. Charges and Molds: Use weld charges and molds sized as specified by the manufacturer for the specific wire size and surface configuration. Weld charges and molds to be Cadweld by Erico or Thermoweld by Continental Industries.

B. Weld Coating: Use Kop-Coat coating as manufactured by Carboline or approved equal.

C. Weld Cap: Cover the coated weld with a plastic weld cap.

PART 3 - EXECUTION

3.1 INSTALLATION OF DEEP ANODE GROUNDBEDS

A. Permits: A qualified well driller who is recognized as a fully experienced specialist in the installation of deep anode cathodic protection systems is required to perform the drilling and installation of the deep anode systems. The deep anode system installer is required to have a minimum of 5 years experience installing deep anode systems with a minimum of 10 successful deep well anode installations. The Contractor is required to obtain and submit all applications for well drilling permits required by any County or State agency.

B. Field Location: Contractor is responsible for verifying actual field conditions, location of underground structures, and assuring adequate physical separation from other structures or utilities. Location of the anode wells is approximate. Determine and verify the exact placement in the field with a representative of the Owner.

C. Anode Hole Drilling: The anode hole to be 8 inches in diameter by 200 feet deep. Perform drilling with rotary bit equipment designed specifically for this purpose. Use standard techniques (i.e. trough and vacuum truck) to capture and contain the drilling fluids, mud and cuttings at the top of the hole. Select the type and consistency of drilling fluids to be consistent with soil characteristics. Level the drilling rig to provide a round, straight and plumb anode hole.

D. Temporary Well Casing: Drilling of the holes may require the installation of temporary well casings. Driller to remove all temporary casings by the end of the job.

E. Anode Hole Geological Logs: As the hole is drilled, the driller to maintain a detailed, formal record describing the depth and type of the geological formations encountered. Submit typed copies of the log as required by 1.05.D.

F. Anode Hole Resistance Log: Record an electric log of the hole using one of the anodes. Previously mark the anode lead wire in five-foot increments. Mark the anode lead wire for a distance equaling or exceeding the maximum anticipated depth of the hole. As the anode is lowered into the hole, perform a resistance log by impressing a minimum 12 volt DC current between the anode and a very well grounded structure such as the local AC power neutral network. Do not use Nilsson type soil resistance meters to perform this test. A recommended 12-volt DC power source is a heavy duty lead acid automobile battery. Lower the anode into the water or drilling mud filled hole at ten foot increments, hold in place, and measure the voltage and current output of the DC current source. Record the data, type and submit as required under Section 1.05.D.

G. Vent Pipe Installation: Install the vent pipe in the hole with the first anode. Cap the bottom of the vent pipe. Cap the top of the vent pipe throughout the anode and coke breeze backfill installation procedure to prevent intrusion of foreign material. Do not allow intrusion of drilling mud into the vent pipe.

H. Anode Installation: The anode well to contain tubular cast iron anodes spaced as required by design. Center the anodes in the hole using anode centralizers. Install the anodes by lowering them individually into the hole by the lead wire.

Mark the lead wires for the nominal anode depth. Record the final depth with the first anode in the hole (i.e. the bottom anode) identified as anode number one (1). Do not damage the anode lead wires during handling or lowering into the hole. Under no circumstances, clamp or pinch the anode lead wires around another object while lowering the anodes into the hole. If the insulation for any anode lead wire is cut, broken or nicked during this operation or at any other time, reject the complete anode assembly remove from the job site immediately. Replace all damaged anodes at no additional expense to the Owner.

I. Anode Column Coke Backfill: Slurry the coke backfill above-grade and then pump into the hole after the anodes are installed. Pump the coke from the bottom of the hole up using a pipe that is the length of the anode hole. Do not use the vent pipe to pump the coke into the hole. Raise the pipe as the anode column is filled with coke. Remove the pipe from the hole after the coke installation operation is completed. Use a sufficient amount of backfill such that the coke breeze column extends a minimum of five feet above the top of the uppermost anode. Use extreme care during installation of the coke backfill so that no voids remain around the anodes.

J. Vent Pipe: Terminate the 1-inch diameter internal vent pipe with a gooseneck fitting. Leave the top end of the vent pipe open to allow gases from the anode hole to exit.

K. Precautions: Take all necessary precautions to avoid entrance of foreign matter into the hole, movement of any soil strata, or collapsing of the drilled hole during the progress of the work. Should movement of soil strata or collapse of the drilled hole interfere with proper completion of the anode groundbed, recover the wires, anodes and vent pipe and ream or redrill the hole at no cost to the Owner.

L. Mud and Cuttings: Dispose of drilling mud, cuttings and other waste in accordance with the methods and procedures of the best recognized practices and comply with the rules and regulations of the State and County.

3.2 INSTALLATION OF CATHODIC PROTECTION RECTIFIERS

A. Codes: Comply with the latest edition of the National Electrical Code (NEC) and with all DFW, and local codes and standards.

B. Mounting: Pole mount cathodic protection rectifiers. The pole may be omitted and the rectifier mounted on a building wall or other available permanent structure, if approved by the Owner or its designated representative. Install rectifiers at a minimum height of 4 feet above final grade.

C. Conduit: Place all wiring to the rectifier in rigid galvanized steel conduit when run above grade.
1. Use insulating bushings at each end of all conduit runs.
2. Extend steel, rigid conduit 12 inches below grade.

D. Electrical Service: Provide AC electrical service for each rectifier unit. Furnish and install the necessary wiring, conduits, wires, meter sockets, splice boxes and equipment to the service connection as required by the local power company.

E. Completion: The installation is not considered complete until the AC and DC wiring is installed and the rectifier is capable of operating at full rated load. Install AC power such that the rectifier can be activated for test purposes. Leave the power off after test

3.3 INSTALLATION OF WIRE AND CABLE

A. Depth: Install all underground wires and cables at a minimum of 24 inches below final grade with a minimum separation of 12 inches from other underground structures.

B. Conduit: Enclose all positive and negative cables in rigid galvanized steel conduit when above-grade.
   1. Use insulating bushings at the ends of all conduit runs.
   2. Extend conduit 12 inches below grade.

3.4 INSTALLATION OF JUNCTION TERMINAL BOXES

A. Location: Install junction terminal boxes immediately adjacent to the rectifier to allow ready access for testing. Install at a minimum height of 3 feet above grade.

B. Concrete Pad: Set junction terminal boxes in a Portland cement concrete pad. The concrete pad to be a minimum of 12 inches in diameter and no less than 24 inches deep. Extend the concrete surface approximately 3 inches above grade.

C. Conduit: Enclose all cathodic protection wiring between the junction box and the rectifier in rigid, galvanized steel conduit. Use insulating bushings at the ends of all conduit to prevent damage to wire insulation.

3.5 NEGATIVE CABLE ATTACHMENT

A. Attach negative cables to the pipe by thermite welding.

B. Clean and dry the tank surface to which the wires are to be attached.

C. Use a grinding wheel to remove all coating, mill scale, oxide, grease and dirt from an area approximately 3 inches square. Clean the surface to bright metal.

D. Remove approximately 1 inch of insulation from each end of the wires to be thermite welded to the chime of the tank exposing clean, oxide-free copper for welding.

E. Using the proper size thermite weld mold as recommended by the manufacturer, place the wire between the graphite mold and the prepared metal surface. Use a copper sleeve crimped over the wire for all wires No. 12 AWG.

F. Place the metal disk in the bottom of the mold.

G. Place the thermite weld charge in the mold. Squeeze the bottom of the weld charge container to spread ignition powder over the charge.

H. Close the mold cover and ignite the starting powder with a flint gun. Hold the mold firmly in place until all of the charge has burned and the weld has cooled slightly.

I. After the exothermic reaction, remove the thermite weld mold and gently strike the weld with a hammer to remove the weld slag. Pull on the wire to assure a secure connection. If the weld is not secure or the wire breaks, repeat the procedure.

J. If the weld is secure, coat all bare metal and weld metal with epoxy paint.

3.6 INSTALLATION TESTING OF THE CATHODIC PROTECTION SYSTEMS

A. General: After the system has been installed, inspect, energize, and adjust as necessary to achieve compliance with accepted corrosion control standard set forth by NACE, the cathodic protection system as soon as possible.

B. Energization: Perform the initial energizing of the cathodic protection system by a Corrosion Engineer of Record.

C. Notice: Prior to native state, polarized potential testing, and commissioning of the system, give a minimum of 48 hours notice to Owner representative to facilitate observation of the tests.

D. Method: The Corrosion Engineer of Record to:
1. Observe native state and polarized (Instant Off) tank-to-soil potentials to ensure that cathodic protection is being provided to the tank bottom in accordance with accepted NACE criteria.
2. Record tank-to-soil potential measurements on the permanent reference electrode and around the perimeter of the tank.
3. Determine if interference exists on nearby structures and, if so, take steps to find a satisfactory solution to the problem.

E. Verification and Responsibilities
1. Correct, at his expense, any deficiencies in materials or installation procedures discovered during the post-installation inspection.
2. Provide written documentation of any deficiencies discovered during the post installation inspection.

F. Equipment: All cathodic protection testing instruments to be in proper working order and calibrated according to factory specifications.

G. Report: Submit a written report in accordance with Section 1.05, Submittals.

PART 4 – MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

A. No direct measurement will be made for the material, equipment, or labor required by this item. Payment for the Work performed as well as the materials and equipment furnished under this item will be paid for each Cathodic Protection System. The Cathodic Protection Systems are either classified as

Interior or Exterior. Payment shall be full compensation for all labor, tools, equipment, materials, repairs, time and incidentals necessary to complete work.

END OF SECTION

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SECTION 13 33 00

WELDED STEEL TANKS ROOF REPLACEMENT

PART 1 – GENERAL

1.1 SUMMARY

This section covers the removal of existing tank roofs, and the design, fabrication, and installation of a replacement roof structure.

1.2 SCOPE OF WORK

A. Design, furnish labor, materials, equipment, and incidentals as required to install the replacement roof specified herein.

B. Incidentals include modifications to the existing tank to make the tank suitable for the roof, included, but not limited to:

1. Removal of existing roof, support columns, rafters, and repair existing structure as necessary

2. Add hatches and appurtenances as indicated on the plans.

3. Bidders shall assume knuckle is in good condition and does not need to be removed. See section 43 45 13 for tank inspection requirements.

1.3 DESIGN REQUIREMENTS

A. Design the roof in accordance with Section 43 41 13 Welded Steel Tanks.

B. Where that standard uses the term “Purchaser”, it shall be meant to refer to the design engineer engaged by the Contractor, except where the information called for is provided herein.

1.4 GUARANTEE

A. The roof structure furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period of five (5) years from the date of acceptance thereof either for beneficial use or final acceptance, whichever is earlier. Upon notice from the Owner of failure of any part of the guaranteed roof during the guarantee period, the affected roof components or parts shall be replaced promptly with new components by, and at the expense of, the Contractor.

1.5 SUBMITTALS

A. Submit the following with the Proposal:

1. Experience List: A completed contracts summary shall demonstrate that the firm has a minimum ten years experience in either retrofitting or installing new, replacement roofs to steel ground storage tanks, and list a minimum of five tanks of equal or greater capacity in successful operation for at least three years. Provide the location, capacity, year completed, contact names and phone numbers. Failure to provide this information shall be cause for rejection.

2. Roof Replacement Drawing: A preliminary section view drawing of the proposed roof for this project. The drawing shall include sufficient detail

to illustrate materials of construction, primary dimensions, how the existing tanks will be modified to accommodate the roof.

3. The replacement roof shall be designed with a crow nest at the peak of the roof.

B. Roof Removal Plan:

Provide a plan for removal of tank roof including equipment height and drawings.

C. Construction Drawings

Provide elevation, plan and sectional view drawings of the roof, tank modifications, tank and appurtenances details, and all appurtenant equipment and accessories as specified. Show the location, dimensions, material specifications, and finish requirements. The submittal shall be signed and sealed by a professional engineer licensed in the State of Texas.

1.6 EXISTING TANK – The actual thicknesses of the shell courses are unknown at the time these specifications were compiled. HMT Inspection performed an inspection of Tank #1 (north tank) at the East Pump station to determine tank shell and bottom thicknesses (see Appendix A). The overall scope of work requires an inspection of the remaining (3) ground storage tanks that will reveal the shell course thicknesses among other physical features. For the purposes of bidding, the bidder shall base its design on the following:

Tank element thicknesses for design of roof.

Element	Units	East Tanks	West Tanks	
Diameter (ft)	feet	142	101	
Bottom API 650	inches	See Appendix A	0.25	1/4
Shell#1		See Appendix A	0.45	7/16
Shell#2		See Appendix A	0.30	5/16
Shell#3		See Appendix A	0.25	1/4
Shell#4		See Appendix A	0.25	1/4
Roof		See Appendix A	0.1875	3/16

Corrosion Allowance: None
Anchors: None

PART 2 – PRODUCTS

2.1 MATERIALS

Material and equipment shall be new and free of rust, pitting scale, or other evidence of used material.

2.2 ACCESSORIES

A. The roof replacement shall include roof access hatches, cathodic holders, handrails, platforms, and all other appurtenances as shown on the plans.

B. Roof Vents – See Section 43 41 08.

PART 3 – EXECUTION

3.1 INSPECTION

Upon receipt of material at job site, the Contractor shall inspect materials for shipping damage.

3.2 INSTALLATION

A. Installing contractor to coordinate and verify that other construction trades and materials have been installed per the contract drawings, and, that they are accurate in location, alignment, elevation, and are plumb and level.

B. Install in accordance with the installation drawings supplied by the roof replacement contractor.

C. Install materials accurately in location and elevation, level, and plumb. Field fabricate as necessary for accurate fit.

PART 4 – MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Removal of roof, rafters, column, cathodic protection, and roof appurtenances will be measured Each (EA) per tank.

Replacement roof will be measured per Each (EA).

4.2 Payment

The work performed and materials furnished in accordance with this item and measured as provided under “Measurement” will be paid for at the unit price for the ”Roof Removal” and “Roof Replacement”. This price shall be full compensation for removing or installing and all labor, tools, equipment, transportation, and incidentals.

Payment will be made under:

Pay Item 13 33 00-1	Remove Existing Roof, Rafters, Columns, Cathodic Protection, and Roof Appurtenances per Each
Pay Item 13 33 00-2	Install New Roof, Rafters, Columns, Access Hatches, and Roof Appurtenances per Each

-END OF SECTION-

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SECTION 43 45 13

INSPECTION WELDED STEEL TANKS

PART 1 – GENERAL

1.1 This specification covers the inspection of the East and West Pump Station Ground Storage Tanks. The north tank (Tank #1) of the East Pump Station Ground Storage tanks has already been inspected, the inspection report can be found in Appendix A. The tanks have not changed service, and no change of service is anticipated. The proposed rehabilitation will include a new roof, a number of minor modifications and a new interior and exterior coating.

1.2 For bidding purposes, Contractor shall assume that the remaining three tanks, one tank at East Pump Station and two tanks at West Pump Station, have the same shell plate thickness and floor thickness as Tank #1 of the East Pump Station.

1.3 Owner will drain each tank 30 days prior to Contractor's anticipated start of work on each tank. Contractor shall complete tank inspection within these 30 days. Contractor shall formally notify Owner of any change of conditions within these 30 days.

1.4 Work is to be conducted in accordance with the requirements of American Petroleum Association 653 – 2012, Tank Inspection, Repair, Alteration and Reconstruction.

1.5 Contractor shall conduct appropriate safety evaluations and lock and tag outs completed, including confined space procedures in accordance with 29 CFR 1910.146 and OSHA. Contractor shall coordinate with OAR to assure a safe working environment.

1.6 Only one tank will be out of service at any given time.

1.7 The tanks were constructed in 1972. The fabrication drawings are unavailable. There is no nameplate on any of the tanks indicating that they were constructed to any particular standard.

1.8 The tanks will have the coating still on them when the tests are conducted.

1.9 OAR will drain the tanks to the minimum depth possible. Contractor is responsible for complete emptying of the tank, cleaning, and preparing corroded surfaces sufficient to allow proper operation of the inspection equipment.

1.10 Lighting, ventilation, and air monitoring are the responsibility of the Contractor.

1.11 Schedule. The tank inspection as described in Part 3 shall be conducted before the rehabilitation work starts. The objective of the first inspection is to identify and quantify rehabilitation items.

1.12 QUALITY CONTROL

A. Tank inspection by means of equipment shall be conducted by personnel certified to operate the equipment used.

B. Equipment calibration records shall be provided to the OAR. Calibration shall be conducted per the equipment manufacturers instructions.

C. API 653 inspection shall be conducted by an authorized inspector as defined in Section 3 of API 653.

D. The crew shall consist of an Inspector certified per API Standard 653, Non Destructive Testing (NDT) crew supervisor, an advanced mapping magnetic flux leakage operator/ NDT Technician (Ultrasonic Level II), and safety attendant.

1.13 SUBMITTALS

A. Documentation indicating the certification of the personnel that will conduct the work. Submit two weeks before inspection.

B. Descriptive manuals on the inspection equipment, including operating instructions. Submit two weeks before the inspection.

C. A report of the API 653 inspection. Submit two weeks before the work begins.

D. A report of the magnetic flux leakage/ultrasonic testing. The report shall include:

1. A Description of the work

2. The results of the inspection including full-floor mapping of both the underside and the topside, NDT data with applicable data tables including location and remaining thickness of any recordable product side or soil side bottom metal loss.

3. Calibration records

4. Recommendation for repair.

E. A report describing the results of tank testing and measurement of the shell, knuckle, nozzles, and ancillary equipment. Drawings showing the locations and thicknesses of the metal shall be submitted instead of the full-floor mapping.

F. Settlement test report. Include a graphical representation illustrating tank shell settlement with a cosine curve fit.

PART 2 – MATERIALS

This part not used.

PART 3 – EXECUTION

3.1 TANK BOTTOM

A. Inspection will be conducted by advanced mapping magnetic flux leakage scanning of the entire tank bottom in a manner that detects the extent and location of underside and topside corrosion with indications confirmed with Ultrasonic testing (UT) and pit gauging

B. Ultrasonic testing of the critical zone with a 12-inch (circumferentially) by 6-inch (towards tank center) scrub at each perimeter settlement survey location. These areas are to be noted on the bottom layout and include minimum and average. If recordable corrosion is detected, notify client immediately.

C. Ultrasonic testing of the tank bottom with one (1) reading per plate.

D. Visual inspection (VT) of the bottom plate lap welds, internal and external shell- to-bottom welds and the bottom-to-sump and sump welds.

E. Vacuum Box Bubble testing (LT\BT) of the bottom plate lap welds.

F. Vacuum Box Bubble testing (LT\BT) of the internal shell-to-bottom weld.

G. Visual inspection of the inlet and outlet ports of all welds and ultrasonic testing of the sides and bottom.

3.2 TANK SHELL AND KNUCKLE

A. Ultrasonic testing of the tank shell and knuckle

B. Shell – At each course and each of 4 quandrants. Take 4 thickness readings. For a total of 64 thickness readings.

C. Knuckle – Four (4) readings (12, 3, 6, and 9 O' Clock) along knuckle. Take 1 thickness reading report for a total of four readings per tank.

3.3 NOZZLE NECKS

A. Ultrasonic testing of the nozzle necks with four (4) readings each (12, 3, 6 & 9 O' Clock).

B. Visual inspection and engineering evaluation per API Standard 653. This shall include a direct visual inspection of all accessible first course and nozzle welds.

3.4 API 653 INSPECTION.

Conduct using the Tank Out-of-Service Inspection Checklist in Appendix C, API 653.

3.5 Shell Settlement Evaluation

Settlement measurements and evaluation of bottom settlement per API Standard 653, Annex B. Paragraphs in B.2.2.

3.6 BOTTOM TESTING

Consideration should be given to performing helium leak testing of the tank bottom after tank repairs. Helium leak testing has proven to be effective in finding small leaks, which may not be detectable with vacuum box and other NDT techniques. Such tests shall be performed at Contractor's expense with no additional cost to the OAR.

PART 4 – MEASUREMENT AND PAYMENT

No direct measurement will be made for the material, equipment or labor required by this item. Payment for the Work performed as well as the materials and equipment furnished under this item will not be paid separately, it is incidental to roof replacement.

-END OF SECTION-

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