

Special Specification Item 4157

Repair Cathodic Protection Pile Jackets



1. DESCRIPTION

Furnish all labor, materials, tools, equipment, and supervision necessary for repairing the cathodic protection Fiber Reinforced Polymer (FRP) pile jackets as shown in the plans.

2. MATERIALS

Provide materials meeting the following physical property requirements:

- 2.1. **Epoxy Repair Material.** Shall meet the following requirements
- Epoxy for Crack Injection. Type IX per DMS-6100, Epoxies and Adhesives.
 - Epoxy for Sealing the Surface of Cracks. Type V or VII per DMS-6100.
- 2.2. **Repair Fill Material.** Provide dry-pack grout to fill cavities or holes in the FRP jackets meeting the requirements of DMS-4675, *Cementitious Grouts and Mortars for Miscellaneous Applications*. A pre-bagged concrete repair material suitable for vertical or overhead applications in accordance with DMS-4655, *Concrete Repair Materials*, may also be used.
- 2.3. **PVC Conduit and Fittings:** Provide rigid PVC conduit and fittings conforming to the requirements of EPC-40-PVC conduit of NEMA TC 2 and fittings for EPC-40-PVC conduit of NEMA TC 3. Provide conduit and fittings that are UL 651 listed and conforming to Article 347 of the Electrical Code for underground and exposed use.
- 2.4. **Junction Boxes:** Marine listed, NEMA Enclosure Type 4X waterproof enclosures, and cable glands.
- 2.5. **FRP Wrap.** Provide glass fiber-reinforced polymer (GFRP) uni-directional fabric with a moisture-tolerant resin or epoxy to reinforce the existing FRP jackets at repair locations. Pre-approved GFRP systems include:
- BASF Masterbrace 900-50FG fabric with
 - SikaWrap Hex 100G fabric with Sikadur 330 or Sikadur Hex 300 resins
 - Simpson Strong-Tire CSS-CUGF27 fabric with CSS-UES Resin
 - Tyfo/Fyfe PR jackets.
 - Other systems may be used as approved. Provide product literature on any proposed system not listed above.
- 2.6. **Bulk Anodes:** 48 lb. minimum zinc units, 99% pure zinc hull type anode with a steel strap core in accordance with ASTM B418, *Standard Specification for Cast and Wrought Galvanic Zinc Anodes*, Type 1. The following manufactures are pre-approved for use on this project:
- Farwest Corrosion Control Company
 - Galvotec Alloys, Inc.
 - Vector Corrosion Technologies
- 2.6.1. **Anode Wiring:** Supply bulk anodes with No. 6 AWG stranded copper wire with HMMWPE insulation brazed to a 3/8 in. diameter steel bar welded to the steel strap core. Provide wire of sufficient length to avoid splicing wires.
- 2.7. **Submittals**

Provide the following information to the Engineer:

- Manufacturer's literature and technical data for each type of manufactured material and product indicated.
- CP quality control plan with proposed testing means and methods, and sample data collection forms.
- Shop drawing details for electrical connections of bulk anodes. Provide proposed electrical connection details approved by the anode manufacturer. Include connections to bulk anodes, embedded reinforcing steel, and junction boxes.

- 2.7.1. **Samples:** Provide one bulk anode proposed for the Project for each type of manufactured material and product indicated. If multiple manufacturers are to be used, provide one sample from each supplier.

3. EQUIPMENT

Provide equipment described in the Department's *Concrete Repair Manual* for epoxy injection, crack repairs, grout installation, and surface preparation. Provide equipment and tools as necessary for FRP fabric installation.

4. CONSTRUCTION

- 4.1. **Field Quality Control:** Engage a NACE-qualified cathodic protection technician (CP-2 qualification or higher) to confirm electrical testing of anodes before and after jacket repairs as described herein.
- 4.2. **Cracked Jacket Repair.** Follow the procedures outlined in the Departments' *Concrete Repair Manual* for crack sealing and injection at Piles 3G and 3H.
- 4.3. **Jacket Hole Repair**
- 4.3.1. Preparation. Sound areas directly around test hole and remove delaminated or deteriorated fiberglass jacket and/or filler material. Wash down repair surfaces with fresh (non-saline) water immediately before application of repair material.
- 4.3.2. Application of Repair Material. Mix and apply repair filler material in accordance with manufacturer's instructions. Fill the entire cavity using dry-pack methods and finish the surface of repair material flush with surrounding fiberglass jacket.
- 4.4. **FRP Application.** Clean the exterior surface of the repair with fresh (non-saline) water before applying the FRP wrap to the repair area. Surface Finishing. Remove all hardened epoxy or grout from the fiberglass jacket surface by grinding or other approved methods. Finish the surface of the cracks or holes flush with the adjacent FRP surfaces with no indentations or evidence of port fittings. Apply two (2) layers of GFRP fabric to the repaired area as shown in the plans. Follow the manufacturer's recommendations for surface preparation of the existing FRP jacket and the previously completed crack or hole repairs.
- 4.5. **Junction Boxes**
- 4.5.1. Inspection of Junction Boxes. Open and inspect all existing junction boxes installed as part of the original cathodic protection pile jackets. Engage a NACE-qualified cathodic protection technician (CP-2 qualification or higher) to perform these inspections and provide a report summarizing the conditions observed at each junction box with recommendations for any necessary repairs to restore functionality or durability. Remove all dust, debris, and other contaminants from junction boxes that are to remain. Replace any junction box that is no longer waterproof due to cracks, damage, or other causes. Follow mounting details provided as submittal for Special Specification *Cathodic Protection System Conversion to Bulk Anodes*. Replace any cracked or broken conduits.

4.5.2. Cleaning of Connections. Clean all connectors and wired ends using a wire brush, scotch-brite® pad, or similar to remove loose rust and mill scale and expose clean metal. Ensure the DC resistance at each connection is less than or equal to 0.5 ohms. If connection does not meet resistance requirements after cleaning, connection may be made by resistance welding a small diameter bar to each wire or other approved means. After continuity has been verified, coat continuity welds with 100% solids epoxy. Correct discontinuous connections by cleaning of connection or other approved means.

4.6. Repair Ground Connection Wiring

Clean and repair the ground connection at Pile 5C. Ensure the DC resistance is less than or equal to 0.5 ohms. If connection does not meet resistance requirements after cleaning, connection may be made by resistance welding a small diameter bar to each wire or other approved means. After continuity has been verified, coat continuity welds with 100% solids epoxy.

4.7. Anodes

4.7.1. **Clean and Inspect Bulk Anodes.** Inspect anodes at each pile jacket for condition, electrical performance, and rate of consumption. Thoroughly clean anode surfaces of all marine growth, mud, rust, loose concrete, micro-organisms, and any other deleterious material. Weigh all anodes after cleaning and replace bulk anodes with more than 25% consumption, or that are unserviceable due to damage, or poor electrical performance. Perform the following quality control testing of existing CP jackets and anodes and provide report to Engineer for review.

- Electrical Continuity: Confirm the DC resistance between each structure negative connection is less than or equal to 1 ohm.
- Circuit Resistance: Measure AC Resistance between the anode and embedded steel. A measurement greater than 0.5 ohms indicates a likelihood of no electrical shorts.
- Current Output: Measure DC voltage across a 0.1Ω shunt to calculate total current. Also measure current for each anode (bulk and jacket).
- Polarization Decay Testing. Perform polarization decay testing on each pile by recording the on potential, opening the circuit, and recording the instant off and off potentials (after minimum 4 hour decay) in accordance with NACE SP0408 - "Cathodic Protection of Reinforcing Steel in Buried or Submerged Concrete Structures". Perform potential readings at face of pile by drilling cored hole (2-in. nominal diameter) through the jacket and zinc mesh for monitoring potentials. Install monitoring port 2 ft. below top of jacket if no monitoring point is present.

4.7.2. **Alternate: Install New Bulk Anodes.** As an alternate to Provisions of Section 4.7.1 above, install new bulk anodes, including required installation hardware and electrical connections at all jackets. Existing bulk anode and corresponding wiring may remain (clean existing connections). Perform the following quality control testing of existing CP jackets and new bulk anodes and provide report to Engineer for review.

- Electrical Continuity: Confirm the DC resistance between each structure negative connection is less than or equal to 1 ohm.
- Circuit Resistance: Measure AC Resistance between the anode and embedded steel. A measurement greater than 0.5 ohms indicates a likelihood of no electrical shorts.
- Current Output: Measure DC voltage across a 0.1Ω shunt to calculate total current. Also measure current for each anode (bulk and jacket).
- Polarization Development Testing. Perform polarization development testing on each pile by recording the native/static potential, closing the circuit, and recording the on, and instant off potentials (after minimum 4 hr.) in accordance with NACE SP0408 - "Cathodic Protection of Reinforcing Steel in Buried or Submerged Concrete Structures". Perform potential readings at face of pile by drilling cored hole (2-in. nominal diameter) through the jacket and zinc mesh for monitoring. Install monitoring port 2 ft. below top of jacket if no monitoring point is present. Ensure existing CP system is left open (off) for minimum of 24 hr. before recording native/static potentials when performing polarization development testing of new bulk anodes.

5. MEASUREMENT

This Item will be measured as follows for the various items of work listed:

■ BBBB-6001 Repair Cathodic Protection Pile Jacket (Crack)	EA
■ BBBB-6002 Repair Cathodic Protection Pile Jacket (Hole)	EA
■ BBBB-6003 Repair Cathodic Protection Pile Jacket (Insp Junction Box)	EA
■ BBBB-6004 Repair Cathodic Protection Pile Jacket (Wiring)	EA
■ BBBB-6005 Rep Cathodic Protection Pile Jacket (Anodes)	EA
■ BBBB-6006 Rep CP Pile Jacket (replace junct. box)	EA

Additional repair work directed or approved by the Department will be measured as outlined in Article 4.4, *Changes in the Work*. The measurement for anodes listed above includes either both alternates for the anodes listed in Articles 4.6.1 and 4.6.2.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid at the unit price bid for the following Items of work:

- Cracked jacket repair - includes crack sealing and epoxy injection at piles 3G and 3H and at other locations as directed or approved. Includes FRP wrap to cover repairs.
- Jacket hole repair - includes cleaning hole at pile 5H, installing grout or repair mortar, and application of FRP wrap to cover repair at pile 5C and at other locations as directed.
- Inspection and cleaning of junction boxes - Includes inspection of each box by CP2 specialist, listing of findings, cleaning and testing of electrical connections, restoration of connections as required to lower DC resistance, and replacement of damaged junction boxes as necessary.
- Repair Ground Connection Wiring - Includes repairs and testing of ground connection at pile 5C and restoration of connections as required to lower DC resistance.
- Inspect anodes - Includes labor and equipment necessary to inspect all existing jacket anodes and connections.
- Replace bulk anodes - Includes labor, anodes and wiring necessary to replace anodes that are damaged or not functioning.
- Polarization testing and report
- Replace junction boxes or conduit - Includes labor, waterproof junction boxes, and installation hardware necessary to replace damaged or defective junction boxes or conduit.

For each of the items listed above the unit prices are for full compensation for supplying, testing and installing the items listed herein and furnishing all labor, equipment, tools, and incidentals to complete the work.