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**PART II - CONSTRUCTION MATERIALS AND METHODS  
SECTION 35**

**INDUSTRIAL PIPING, EQUIPMENT & STEEL TANK REHABILITATION**

**35.1 GENERAL**

Rehabilitation work on industrial piping, clarifiers, flocculators, flumes, steel tanks, etc., owned and/or operated by the City shall be performed in accordance with approved engineered plans, these Specifications and the General Conditions of the Engineering Code of Standard and Specifications for the Design and Construction of Public Improvements of the City of Arvada.

Rehabilitation shall consist of the preparation and painting of submerged and exposed metal surfaces, and the furnishing and installation of cathodic protection material and equipment to control corrosion of the metal. Hangers for anode systems shall be installed immediately following blasting of the steel surface then primed and painted in accordance with the requirements set forth herein.

Anodes and collector circuits shall be installed after the paint system has been applied. Rigid conduit and appurtenances shall be installed immediately after exposed surfaces have been primed.

Cathodic rehabilitation and painting of industrial metal surfaces shall be coordinated by the General Contractor. Cathodic reconditioning shall be performed by a qualified cathodic protection company certified by NACE. Paint systems shall be applied by a firm specializing in industrial piping and equipment painting.

**35.2 MATERIALS**

Materials that are to be furnished, applied on or installed shall conform to the minimum standards hereinafter referred to.

Materials and workmanship shall conform, be equal or exceed the minimum standards as set for by the American Society for Testing Materials (ASTM), the American Association of State Highway Testing Officials (AASHTO), the American Water Works Association (AWWA), the National Association of Corrosion Engineers (NACE), Steel Structures Painting Council (SSPC), Federal Specifications, Bureau of Reclamation Paint Manual, etc. Reference standards shall be of the latest edition or revision thereof.

**35.3 PREPARATION OF STEEL SURFACE FOR PAINT SYSTEM**

Unless modified in the special conditions, submerged and/or exposed metal surfaces shall be blast cleaned in accordance with Steel Structures Painting Council (SSPC) procedures, to the degree of surface cleanliness as herein below specified and defined, prior to applying the paint system.

35.3.1 Near White Cleaned Metal Surface SSPC - SP10 - Tank Interior and Submerged Surface

A near-white blast cleaned surface finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks, or slight discolorations caused by rust stain, mill scale oxides, or slight, tight residues of paint or coating that may remain.

At least 95% of each square inch (645.2 sq. mil.) of surface area shall be free of all visible residues, and the remainder shall be limited to light discoloration mentioned above.

35.3.2 Commercial Cleaned Metal Surface SSPC - SP6 - Exterior and Non-submerged Surface

A commercial blast cleaned surface finish is defined as one from which all oil, grease, dirt, rust scale and foreign matter have been completely removed from the surface and all rust, mill scale, and old paint have been completely removed except for slight shadows, streaks, or discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating that may remain; if the surface is pitted, slight residues of rust or paint may be found in the bottom of pits; at least two-thirds of each square inch (.00065 sq. mil) of surface area shall be free of all visible residues and the remainder shall be limited to the light discoloration, slight staining or light residues mentioned above.

35.3.3 Treating Blast Cleaned Metal Surfaces

Blast cleaned surface shall be primed within eight (8) hours after blasting when practicable, but in any event not later than twenty-four (24) hours after blasting and before any visible or detrimental rusting occurs. Surfaces which rust before painting is accomplished shall be recleaned by the Contractor at his expense.

**35.4 PAINT SYSTEM**

Metal surfaces after blast cleaning, shall be primed and painted using today's (standards and practices) best technology and materials pre-approved by the Engineering Division. No request for material substitution will be considered that would decrease film thickness, number of coats or alter a change in the generic type of coating specified. Paint application and dry film thickness shall conform to AWWA Inside System No. 1.

35.4.1 Submerged Metal, Tank Interior Non-Submerged

Surface Preparation: SSPC-SP10, Near White Blast Cleaning

<u>Coat</u>	<u>Color</u>	<u>Paint System</u>	<u>Dry Film Mils</u>
Prime	Beige	Tnemec 20-1255 Pota-Pox Cook Epicon MW High Build Epoxy	4.0 - 6.0
Finish	White	Tnemec 20-2000 Pota Pox Cook Epicon MW High Build Epoxy	4.0 - 6.0 <hr/> 8.0 - 12.0

35.4.2 Non-Submerged Metal

Surface Preparation: SSPC-SP6, Commercial Blast Cleaning

<u>Coat</u>	<u>Color</u>	<u>Paint System</u>	<u>Dry Film Mils</u>
Prime	Red	Tnemec 66-1211 Hi-Build Epoxoline Cook-Co poxy Primer	4.0 - 6.0
Finish	Desert Sand	Tnemec Series 71 Endura - Shield Cook-Acrothane	1.5 - 2.5 <hr/> 5.5 - 8.5

35.4.3 Steel Tank Exterior

Surface Preparation: SSPC-SP6, Commercial Blast Cleaning

<u>Coat</u>	<u>Color</u>	<u>Paint System</u>	<u>Dry Film Mils</u>
Primer	Aluminum	TNEMEC 50-330 Poly-URA-Prime Cook-Corothane 502	2.5 - 3.0
Finish	Desert Sands	TNEMEC Series 73 Endura Shield III Cook-Acrothane II	4.0 - 5.0 <hr/> 6.5 - 8.0

**35.5 PAINTING**

Paint shall be homogeneous, free of contaminants, and of a consistency suitable for the use for which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle according to the requirements of the paint; and this dispersion shall be of such nature that the pigment does not settle appreciably, does not cake or thicken in the container, or become granular or curdled. Paint and paint materials shall be delivered to the job site in new, unopened, air-tight containers, appropriately identified with the manufacturer's name, date of manufacture, type of paint or paint material, state specification number, lot or batch number, and accompanied with an M.S.D.S. sheet.

35.5.1 Weather Conditions and Ventilation

Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided herein, painting will not be permitted when weather conditions are such that the receiving surface temperature is at or below 50 degrees F, or when freshly painted surfaces may become damaged by rain, fog, or condensation. If fresh paint is damaged by the elements, it shall be replaced by the Contractor at his expense. Coatings are to be applied in accordance with the paint manufacturer's printed instructions.

Inside tank or buildings, the Contractor must provide adequate ventilation which will effectively remove air borne dust and evaporated solvents within the specified drying time of the paint. Ventilation shall meet current Occupational Safety and Health Administration (OSHA) standards. Provisions must also be made to artificially control atmospheric conditions within limits suitable for painting inside and throughout the painting operation. The cost of providing and maintaining such conditions shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefore.

#### 35.5.2 Thinning Paint

Thinning shall be per manufacturer's printed instructions.

#### 35.5.3 Application

Painting shall be done in a neat and workmanlike manner. Unless otherwise specified, paint shall be applied by brush, roller, or spray methods in accordance with the paint manufacturer's recommendations.

**The prime coat shall be applied by brush to all weld seams, bolt heads, sharp corners and edges, immediately following blasting.** The City Engineer or designee shall determine which areas must be brushed. **It is anticipated that 90% of all edges or corners will be deemed "sharp" and therefore need to be brushed.** Care shall be exercised to insure that all close areas are holiday free. Also, paint shall be considered to have been improperly applied if an inordinate amount of residual brush marks remain.

Where spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

A water trap acceptable to the engineer shall be furnished and installed on all equipment used in spray painting.

Mechanical mixers shall be used to mix the paint a sufficient length of time to assure a thorough mix of the pigment and vehicle. To keep the pigment in suspension, paint shall be kept thoroughly mixed while being applied.

#### 35.5.4 Paint Coats

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film. All previous coats of paint shall be dry and fully cured and the surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding paint coats.

The dry film thickness of each coat of paint shall be measured in place with a calibrated magnetic film thickness gauge by the Contractor, in the presence of the project engineer or his authorized representative. Each surface coat of paint shall also be of a different color.

#### 35.5.5 Curing

Elapsed time for curing between brush and/or roller priming of weld seams, interior primer and finish coat shall be in accordance with the paint manufacturer's recommendation. The

cure time between finish coat and immersion in water of the painted surface shall be equivalent to seven (7) days at a mean average temperature of 75 degrees F.

#### 35.5.6 Protection of the Work

The Contractor shall protect all parts of the structure against disfigurement as a result of his blasting and painting operations. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons, or adjoining property, and shall provide at his expense protective means to guard against such damage.

Paint stains on adjacent improvements which result in an unsightly appearance shall be removed by the Contractor at his expense.

When ordered by the engineer to abate a dust nuisance and to protect the wet paint film, the Contractor shall dampen the adjacent areas with water at his expense on each side of the location where painting is in progress. The Contractor shall furnish and post at his expense DRIVE SLOWLY signs and take other Precautions necessary to prevent dust and dirt from accumulating on freshly painted surfaces.

#### 35.5.7 Housekeeping and Cleanup

At all times during the performance of the work, the Contractor shall maintain the site in a reasonable state of order and cleanliness. Upon completion the Contractor shall remove from the job site all sand, rubbish, unused materials, etc., and repair any damages resulting from his operation, leaving the site in a condition equal or better than existed at the commencement of the work.

### 35.6 **CATHODIC PROTECTION SYSTEM FOR STEEL TANKS**

The cathodic protection system shall be installed in tanks which are subjected to freezing and thawing cycles during the winter months. The system shall be of the submerged anode type.

The system shall be designed for and demonstrated capable of continuously providing one milliamperere of direct current per square foot of interior tank wall and bottom surface.

#### 35.6.1 Rectifier

The rectifier unit shall be housed in a weather proof cabinet with provision for locking. The rectifier shall be selenium or silicon, and shall be equipped with an integral AC isolation transformer, a unit voltmeter and a separate ammeter for each output circuit. The secondary voltage output shall be manually adjustable in 20 or more equal steps from 0-100% of rated capacity. The rectifier shall be as manufactured by Good-All, or approved equal.

#### 35.6.2 Automatic Controller

The controller shall be housed integrally with the rectifier unit in the weatherproof cabinet. The automatic controller shall be of completely solid state design, having no moving Parts, and shall be capable of automatically maintaining the tank-to-water potential at (-) 900 millivolts with respect to a copper-copper sulfate reference electrode within an accuracy of 25 millivolts. The tank-to-water potential measured and maintained by the controller shall be free of "IR" drop error.

35.6.3 Tank-to-Water Potential Meter

The controller shall be equipped with a calibrated voltmeter which shall be so connected to read, from the system reference cell, the tank-to-water potential being maintained by the cathodic protection system. This voltage reading shall be free of "IR" drop error.

35.6.4 Reference Electrode

The system shall be equipped with either a copper-copper sulfate or silver-silver chloride reference electrode designed for a minimum five-year life. A second similar reference electrode shall also be installed for system verification testing purposes.

35.6.5 Conductors

All wiring shall have Type "TW" insulation and shall be sized in accordance with the National Electric Code. All wiring installed underground shall have High Molecular Weight insulation for direct burial use. Ground connection of the negative lead shall be made at an accessible point on the tank structure.

35.6.6 Conduit

All conduit shall be of rigid galvanized steel.

35.6.7 Anode

The submerged anode system shall utilize a platinized niobium wire anode. The anode system shall be attached to a stabilized structure which is maintained in a totally submerged condition below the minimum ice free water level by flexible attachment to the tank wall. The anodes shall have a minimum design life of 10 years. Anode and reference electrode lead wires shall enter the tank below the minimum winter ice-water level, through pressure tight fittings.

**35.7 SPECIAL REQUIREMENTS FOR CATHODIC PROTECTION SYSTEM**

35.7.1 Power

The owner shall make 115V, 60 HZ single phase AC power available to the site. The Contractor shall be responsible for furnishing and installing all conduit and wire necessary to connect the rectifier unit at the tank with the power source.

35.7.2 Pre-Construction Submittals

Before any material or equipment is purchased, the Contractor shall submit for approval in quadruplicate, design calculations, a complete list of materials and equipment to be incorporated in the work and the engineering drawings for the submerged anode system(s). The list shall include catalog numbers, cuts, diagrams, drawings and other descriptive data as may be required by the City Engineer or designee. No consideration will be given to partial lists submitted from time to time. Approval will be based on the manufacturer's published ratings. Any materials and specification requirements not in compliance with specifications will be rejected and must be revised and resubmitted.

### 35.7.3 Criteria for Protection

The cathodic protection system shall be capable of automatically maintaining a tank to water potential of (-) 900 millivolts plus or minus 25 millivolts on the entire submerged surface with respect to a copper-copper sulfate reference electrode, which is measured free of electrolyte IR drops. The tank-to-water potentials at which the cathodic protection system is set to operate shall be in accordance with the criteria for protection of steel as established by the National Association of Corrosion Engineers in the NACE Standard RP-01-69.

### 35.7.4 Installation

The system installation shall be coordinated by the General Contractor. Installation shall be by personnel who are specifically trained in this type of work and who are engaged full time in the installation and servicing of cathodic protection equipment. Installation of the submerged anode system and testing thereof shall not be made until the paint system has cured for 7 days.

### 35.7.5 Energizing and Testing

After the installation is completed, the system shall be energized and adjusted for optimum operation by a trained employee of the design engineer. After the unit is adjusted, measurements of tank-to-water potential shall be taken using a copper-copper sulfate half cell a reference electrode. A report shall be submitted which includes all of the test results obtained.

**Note: Permanent induction of current into the anode system will not be allowed until the interior paint system has cured for 28 calendar days.**

### 35.7.6 Training Owner's Personnel

The cathodic protection engineer or his representative responsible for the design and installation of the system, shall check the installation of the equipment, direct the energizing and testing and train owner personnel in the operation and maintenance of the system. A minimum of four hours shall be allocated to training. All costs for such service shall be included in the amount shown on the Bid Schedule for Cathodic Protection.

### 35.7.7 Post-Construction Submittals

Triplicate copies of all fabrication assembly and installation drawings, together with detailed specifications of the design and function of the voltage control system and an O&M Manual for the system shall be submitted to the Owner, prior to their placing the system under warranty.

### 35.7.8 Re-testing

At the end of the one year warranty period, the installing cathodic protection engineering firm shall re-test the system and submit an attendant report to the City. Retesting shall be performed in the presence of the owner's operation and maintenance personnel. All cost for retesting service shall be included in the amount shown on the Bid Schedule for Cathodic Protection.