

TECHNICAL REQUIREMENTS AND SPECIFICATIONS

PROTECTIVE COATING OF STEEL (As Provided by Raven Lining Systems)

FOREWORD

This specification covers work, materials and equipment required for protecting and/or restoring steel structures by monolithic spray-application of a solvent-free, high-build epoxy coating on steel surfaces to eliminate infiltration/exfiltration, provide corrosion protection, repair damaged surfaces and enhance structural integrity. Procedures for surface preparation, cleaning, application and testing are described.

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Solvent-free epoxy coating to be applied to specified surfaces and conforms to the requirements set forth below.

1.02 RELATED SECTIONS

- A. Steel Repair.
- B. Environmental, Health and Safety.

1.03 REFERENCES

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- E. ASTM D2584 - Volatile Matter Content.
- F. ASTM D2240 - Durometer Hardness, Type D.
- G. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- H. ASTM - the published standards of the American Society for Testing and Materials, West Conshohocken, PA.

NACE - the published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

- J. SSPC - the published standards of the Society of Protective Coatings, Pittsburgh, PA.

1.04 SUBMITTALS

- A. The following items shall be submitted:
 - 1 Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
 - 2 Material Safety Data Sheets (MSDS) for each product used.
 - 3 Project specific guidelines and recommendations.
 - 4. Applicator Qualifications:
 - a. Manufacturer certification that Applicator has been trained in the handling, mixing and application of the products to be used.
 - b. Certification that the equipment to be used for applying the products has been approved by the protective coating manufacturer and Applicator personnel have been trained and certified for proper use of the equipment.
 - c. Five (5) recent references of Applicator (projects of similar size and scope) indicating successful application of a high-build solvent-free coating by spray application.
 - d. Proof of any necessary federal, state or local permits or licenses necessary for the project.
 - 5. Design details for any additional ancillary systems and equipment to be used in surface preparation, application and testing.

1.05 QUALITY ASSURANCE

- A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.
- B. (OPTIONAL) A NACE Certified Coating Inspector shall be provided by Owner. The Inspector will observe daily operations, procedures and final product to ensure adherence to the specifications by Applicator.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored between 50 and 90 deg F. Do not store near flame, heat or strong oxidants.
- C. Protective coating materials are to be handled according to their material safety data sheets.

1.07 SITE CONDITIONS

- A. Applicator is to conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Method statements and design procedures are to be provided by Owner when confined space, lock-out, flow diversion or bypass is necessary in order for Applicator to perform the specified work.

1.08 WARRANTY

- A. Applicator shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Applicator shall, within a reasonable time after receipt of written notice thereof, make good defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.

PART 2 - PRODUCTS

2.01 EXISTING PRODUCTS

- A. Specified steel surfaces will be thoroughly inspected.
- B. (OPTIONAL) After blast preparation surfaces may be ultrasonically tested to detect thin spots in the shell where the structural integrity of the structure has deteriorated. After blast preparation these spots should be marked with epoxy spray paint or zinc primer.
- C. Existing coatings should be removed or, where bonded well, thoroughly abraded to provide adequate surface profile for mechanical bond by the new protective coating. Applicator is to maintain strict adherence to the protective coatings manufacturer's recommendations with regard to proper surface preparation and compatibility with existing coatings.

2.02 MANUFACTURER

- A. Raven Lining Systems, Inc., Tulsa, Oklahoma 800-324-2810 or 918-584-2810 or FAX 918-582-4311.

2.03 REPAIR MATERIALS

- A. Repair materials must be accepted and approved for compatibility with the specified epoxy coating.
- B. As an example, the following products could be used within the specifications:
 1. 100% solids solvent-free epoxy grout or gel as AquataPoxy A-7 or AquataPoxy A-6 Thick. Engineer and Owner to specify product dependent upon project, service environment and manufacturer's recommendations.
 2. (OPTIONAL) Fiberglass woven roving fabric, 9 oz/yd², 30" bias. *{Should fiberglass patching be specified details should be included for weight and type of fabric. Strands should be straight and not twisted to accommodate quick wet-out of the fabric by the coating. Millage of the coating must be enough to absorb into and totally encapsulate the fabric.}*

2.04 PROTECTIVE COATING MATERIAL

- A. Raven Lining Systems' *{insert product name}* epoxy coating system - a 100% solids, solvent-free two-component epoxy resin system thixotropic in nature and filled with select fillers to minimize permeability and provide sag resistance acceptable to these specifications (up to *{depends on product}* mils in a single coat).

Product type	Amine cured epoxy
Color	<i>{see product data sheet}</i>
Solids Content (vol %)	100
Mix Ratio	1:1 <i>{Aquatapoxy}</i> 3:1 <i>{Raven}</i>
Compressive Strength	<i>{see product data sheet}</i>
Tensile Strength, psi	<i>{see product data sheet}</i>
Tensile Elongation, %	<i>{see product data sheet}</i>
Flexural Modulus, psi	<i>{see product data sheet}</i>
Hardness, Type D	<i>{see product data sheet}</i>
Bond Strength - SSPC10	<i>{see product data sheet}</i>
Bond Strength - SSPC5	<i>{see product data sheet}</i>
Chemical Resistance to:	<i>{Examples}</i>
Sulfuric Acid, 20%	Immersion Service
Sodium Hydroxide, 50%	Immersion Service
MEK	Incidental Contact
	<i>{include reagents relevant to the project}</i>

2.05 PROTECTIVE COATING APPLICATION EQUIPMENT

- A. Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective coating.

PART 3 - EXECUTION

3.01 ACCEPTABLE APPLICATORS

- A. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

3.02 EXAMINATION

- A. All structures to be coated shall be readily accessible to Applicator.
- B. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies or client specific policies with regard to environment, health and safety.
- C. Any active flows shall be locked-out, plugged or diverted as required to ensure that the liquid flow is maintained below the surfaces to be coated. Any equipment shall be locked-out according to site safety and OSHA requirements.
- D. Temperature of the surface to be coated should be maintained between 40 deg F and 120 deg F during application. The surface temperature of the steel should be maintained at a minimum of 5 deg F above dewpoint during application.

3.03 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the protective coating.
- B. Surfaces shall be free of weld splatter. All welds shall be continuous.
- C. Steel contaminated with soluble salts (ie. chlorides and sulfates) develops rust-back rapidly at intermediate and high humidities. Therefore, these salts must be removed from the steel surface preferably before blast cleaning and by eliminating sources of recontamination during and after blast cleaning. A number of tests for soluble salts have been examined by SSPC, ASTM, the National Shipbuilding Research Program, and the International Organization for Standardization.
(This information was taken from NACE No. 1. Refer to this Standard for additional information.)
- D. All loose scale, large deposits oil, grease, cutting oils, dirt and other contaminants shall be removed prior to abrasive blasting by washing with detergent and potable water, followed by a thorough rinsing with potable water.
- E. The steel surfaces to be coated shall be abrasive blast cleaned. Blast air shall be free of oil and water.

- F. Abrasive shall be ----- {Owner and Engineer to specify *dependent upon project requirements.*}. Abrasive shall not be recycled.
- G. Abrasive blasting shall not be performed when the air or steel temperature is below 40 deg F, when the relative humidity exceeds 80%, or when the steel is less than 5 deg F warmer than the dewpoint. The Contractor will provide dehumidification, and/or temperature control as necessary to meet these conditions.
- H. Blast cleaning shall be in accordance with SSPC-SP 5, White Metal Blast Cleaning for severe-duty immersion service of the coated areas. Blast cleaning for other surfaces shall be in accordance with SSPC-SP 10, Near White Blast Cleaning. Anchor profile shall be 2.5-5.0 mil and relative to the coating thickness specified.

Remove all blasting residues from the structure/vessel by means of vacuum cleaning plus, as appropriate, shovels, brooms, clean compressed air, vacuum cleaners and other dry extraction methods.
- J. All surfaces should be inspected by the Inspector during and after preparation and before the protective coating is applied.

3.04 REPAIR OF STEEL

{This area to be used when the structural integrity of the structure or vessel needs to be enhanced or repaired. }

- A. (Optional) Fiberglass woven roving fabric may be rolled into the resin or chopped glass spray applied with the resin for added tensile and flexural strength where desired or required.

3.05 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. Before spraying any coating, all welds, grooves, pits, other rough areas, difficult-to-spray areas, and other areas as specified shall be striped. Striping can be accomplished by spray application in accessible areas; and, hand-mixing product or spray followed by scrub-striping with a good-quality bristle brush in difficult-to-spray areas.
- C. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- D. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.

- E. Specified surfaces shall be coated by spray application of a moisture tolerant, solvent-free, 100% solids, self-priming epoxy protective coating as further described herein. Spray application shall be to a minimum wet film thickness of ___ mils and an average wet film thicknesses of ----- mils.

Steel: 16-80 mils for immersion, 16-40 mils for atmospheric, splash and spill exposure; also profile dependent.

(Thicknesses shown above are for general purposes only, each project should be evaluated independently and thickness of system determined upon product, service environment, protection and restoration requirements.)

- F. Airless spray application equipment shall be used to apply each coat of the protective coating to avoid any potential contamination from compressed air oil which may encourage inter-coat delamination. Air assisted spray application equipment may be acceptable, especially for thinner coats (<10 mils), only if the air source is filtered to completely remove all oil and water and must be pre-approved by the protective coating manufacturer.
- G. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, but no later than the recoat window for the specified product. Additional surface preparation procedures will be required if this recoat window is exceeded.
- H. (OPTIONAL) Sloped surfaces of the floor may be made non-skid by broadcasting aluminum oxide or silica sand into the surface prior to gelation.

3.06 TESTING AND INSPECTION OF PROTECTIVE COATING

- A. During application a wet film thickness gauge, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.
- B. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RP0188-99). All detected holidays shall be marked and repaired by abrading the coating surface with abrasive paper or brush blast. After abrading, additional protective coating material can be hand applied to the repair area, but should not be applied beyond the abraded area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.
- C. Measure the coating thickness with an ultrasonic thickness gauge to ensure that the required DFT has been applied. Repair low DFT by application of additional coating.

- D. Measurement of bond strength of the protective coating to the substrate can be made at regular intervals and along different sections of the structure. Bond strength can be measured in accordance with ASTM D4541. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of the potentially deficient bonded area and repairs should be made by the Applicator in strict accordance with manufacturer's recommendations.
- E. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.
- F. The system may be put back into non-severe operational service as soon as the coating becomes hard to the touch and the final inspection has taken place. However, for severe corrosion duty such as high concentrations of acids, bases or solvents, 3 to 7 days and/or force cure by heat induction to the coated surfaces may be necessary prior to returning to service. Manufacturer's recommendations should be strictly followed.

END OF SECTION