Standard Practice for
Rapid Evaluation of Coatings and Linings by Severe Wastewater Analysis Test

Scope

1.1 This practice is intended to standardize laboratory test procedures and aid in evaluating the performance of coatings and linings recommended for use in severe wastewater headspace environments.

1.2 This test method covers the procedure for testing the durability of a coating or lining system applied to steel and concrete substrates in a testing chamber designed to simulate the pertinent attributes of a typical domestic severe wastewater headspace environment. The testing chamber comprises two phases: 1) a liquid phase containing a prescribed acid and saline solution, and 2) a vapor phase consisting of air, humidity, and elevated hydrogen sulfide (H_2S) gas (Note 1). The temperature of the test chamber is elevated to create accelerated conditions and reaction rates.

Note 1—Other known sewer gases, such as carbon dioxide and methane can be incorporated into this standard practice to evaluate the effects on protective barrier qualities.

1.3 Caution: This test method can be extremely hazardous. All necessary precautions need to be taken when working with hydrogen sulfide gas and sulfuric acid. It is highly recommended that a professional testing laboratory experienced in the testing with hydrogen sulfide gas perform this standard practice.

1.4 *This standard practice does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[1]

C 307 Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

C 387 Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete

C 580 Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

D 610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces

D 660 Standard Test Method for Evaluating Degree of Checking on Exterior Paints

D 661 Standard Test Method for Evaluating Degree of Cracking on Exterior Paints

D 638 Test Method for Tensile Properties of Plastics

D 714 Test Method of Evaluating Degree of Blistering of Paints

D 790 Standard Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D 2370 Standard Test Method for Tensile Properties of Organic Coatings

D 3665 Standard Practice for Random Sampling of Construction Materials

D 4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tester

D 7091 Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Ferrous Metals

2.2 *ISO Standard:*[2]

ISO 16773 Paints- and Varnishes- Electrochemical Impedance Spectroscopy (EIS) on High Impedance Coated Samples. Part 1: Terms and Definitions

ISO 16773 Paints- and Varnishes- Electrochemical Impedance Spectroscopy (EIS) on High Impedance Coated Samples. Part 2: Collection of Data

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[1] ASTM International (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959 USA (see www.astm.org).

[2] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20, Switzerland (see www.iso.org).

2.3 *NACE Standards:*[3]

NACE No. 1/SSPC-SP5 White Metal Blast Cleaning

NACE No. 6/SSPC-SP13 Surface Preparation of Concrete

NACE SP0892 Coatings and Linings over Concrete for Chemical Immersion and Containment Service

2.4 SSPC *Standards*:[4]

SSPC-SP5/NACE No. 1 White Metal Blast Cleaning

SSPC-SP13/NACE No. 6 Surface Preparation of Concrete

2.5 ICRI *Standard*:[5]

ICRI Guideline No. 03732 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays [ICRI-CSP]

3. Summary of Practice

3.1 The corrosion protection of steel and concrete by a protective coating or lining may be altered by exposure to sewer gases and by the composition of the corrosive reagents found in headspace environments of domestic wastewater conveyance and treatment structures.

3.2 This test method simulates a severe wastewater headspace condition by wetting the coated samples in a cyclic fashion with a corrosive solution and then exposing the samples to air containing hydrogen sulfide—a known sewer gas responsible for altering barrier properties of protective coatings and linings. [6]

3.3 Test specimens are positioned on a carousel and placed inside an airtight test chamber. The chamber contains a prescribed aqueous solution in the bottom and a headspace containing sewer gas. The test specimens are immersed into the aqueous solution (liquid phase) three times a day for a period of 15 minutes each. The specimens are then exposed to the sewer gas (vapor phase) the balance of the time. This cyclic exposure continues for a period of 28 days (Note 2), and produces interpretable data.

Note 2—While this test specifies a testing period of 28 days it may be increased to 30 days (or longer) in order to perform additional periodic EIS permeation testing and coating assessment; see also Note 3.

3.4 Performance measures of the candidate coating or lining system are based upon the retained properties of:

a. Permeability
b. Physical Testing
c. Visual Inspection

3.4.1 *Permeability*—Protective coatings act as a barrier separating the substrate from the corrosive service environment. Polymers with low permeation are assumed to offer better substrate protection within severe wastewater environments.

3.4.2 *Physical Testing*—Protective coatings should not undergo significant physical alterations when exposed to severe wastewater environments. Polymers that retain their physical properties, such as adhesion, tensile strength and flexural properties under such corrosive conditions are assumed to offer better substrate protection within severe wastewater environments.

3.4.3 *Visual Inspection*—Protective coatings should not blister, check, crack, or allow corrosion of the substrate when exposed to severe wastewater environments. Polymers that retain film quality are assumed to offer better substrate protection within severe wastewater environments.

4. Significance and Use

4.1 Domestic wastewater headspace environments are very corrosive due to the presence of sewer gases and sulfuric acid generated during the biogenic sulfide corrosion process. This standard practice simulates an accelerated exposure to sewer gases and the dilute concentration of sulfuric acid commonly produced by bacteria within these environments.

4.2 The results obtained by the use of this standard practice shall be a means for estimating the protective barrier qualities of a protective coating or lining in severe wastewater conditions.

4.3 The results should be interpreted by protective coatings specialists experienced in the field of protective coatings and wastewater. It is often necessary to use other data such as chemical resistance, shrinkage, thermal expansion and abrasion resistance – in addition to the results of this standard practice – to formulate conclusions concerning the suitability of a protective coating or lining and its probable effect on the service life found in a severe wastewater environment.

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[3] NACE International (NACE), 1440 South Creek Dr., Houston, TX 77084-4906 USA (see www.nace.org).

[4] SSPC: The Society for Protective Coatings (SSPC), 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4643 USA (see www.sspc.org).

[5] International Concrete Repair Institute (ICRI), 3166 S. River Road, Suite 132, Des Plaines, IL 60018 USA (see www.icri.org).

[6] Refer to the references at the end of this standard.

5. Test Specimens

It is very important that the test specimens be smooth, completely-continuous films or castings of uniform thickness throughout the test area. The coating thickness shall not vary by more than 10% of the total thickness on any test series.

5.1 All coating materials to be tested or compared shall be applied to the same type and grade of substrate for a given test series.

5.2 The size and shape of the test specimens may vary to conform to the dimensions of the chamber, but shall meet the minimum dimensions specified herein.

5.3 *Steel Specimens*—Abrasive blast clean four ASTM A-36 hot-rolled flat steel panels, minimum size 7.62 cm x 10.16 cm x 0.3175 cm (3 in x 4 in x 1/8 in) to an SSPC-SP5/NACE No. 1 surface cleanliness with the recommended anchor profile required by the coating manufacturer.

5.3.1 Apply the candidate coating or lining system at recommended thickness to the front and back of the panels. Dip the edges (sides, top, bottom) using the candidate coating system (or other compatible material) to protect the edges from corrosion break-through.

5.3.2 Test specimens shall provide a minimum of 61 cm^2 (24 in^2) front and back of coated surface area.

5.3.3 One of the four test specimens is randomly selected for use as a control in accordance with Section 6.

5.4 *Concrete Specimens*—Cast four concrete cylinders using minimum 5,000 psi compressive strength Portland Type 1 design mix conforming to ASTM C 387. The cylinders are to be a minimum size of 3.81 cm diameter x 10.61 cm tall (1½ in x 4 in). Abrasive blast clean the concrete cylinders in accordance with SSPC-SP13/NACE No. 6 with recommended ICRI-CSP surface profile required by the coating manufacturer.

5.4.1 Apply recommended resurfacing material to fill bugholes and surface irregularities of the concrete specimens as recommended per NACE SP0892.

5.4.2 Apply the candidate coating or lining system at recommended thickness to the entire surface of the specimens, including top and bottom. Dip the edges (top, bottom) of the cylinder using the candidate coating system (or other compatible material) to protect the concrete from corrosion break-through.

5.4.3 Test specimens shall provide a minimum of 48 cm^2 (19 in^2) of coated surface area.

5.4.4 One of the four test specimens is randomly selected for use as control in accordance with Section 6.

5.5 *Mechanical Testing Specimens*:

5.5.1 Tensile Testing—Cast two sets of the minimum number of samples specified by the ASTM standard using the candidate coating or lining in accordance with ASTM C 307, ASTM D 638, or ASTM D 2370.

5.5.1.1 One set of the test specimens is randomly selected for use as control in accordance with Section 6.

5.5.2 Flexural Testing—Cast two sets of the minimum number of samples specified by the ASTM standard using the candidate coating or lining in accordance with ASTM C 580 or D 790.

5.5.2.1 One set of the samples is randomly selected for use as control in accordance with Section 6.0.

6. Control Specimens

6.1 One test specimen or set of test specimens—of each test type—shall be randomly selected in accordance with ASTM D 3665. For example, one steel, or concrete specimen, or one set of tensile and flexural specimens shall be randomly selected for control testing.

6.2 Evaluate the color and appearance of the specimens and describe the coating (i.e., rough, smooth, irregular). Notate any coating abnormalities.

6.3 Perform control testing in accordance with the procedures in Sections 10 to 12.

7. Reagents

7.1 *Aqueous Solution*:

7.1.1 10% sulfuric acid (H_2SO_4)—12 liters or the volume required for the samples to be completely immersed when the specimen carousel is in the liquid phase (lowered position).

7.1.1.1 "Percent" is defined as volume of solute per volume of solution. 10% H_2SO_4 contains 97.18 grams of sulfuric acid per liter of acid solution, which is the same as 0.9903 moles of sulfuric acid per liter of acid solution.

7.1.2 0.4% (4000 ppm) sodium chloride (NaCl)—solute by weight in acid solution.

7.1.2.1 "Percent" is defined as weight of solute per volume of acid solution. 0.4% contains 3.973 grams of sodium chloride per liter of acid solution, which is the same as 0.06799 moles of sodium chloride per liter of acid solution.

7.1.3 Sparged with H_2S-containing gas to saturation with composition as in 7.2.

7.2 Wastewater Gas(es):

7.2.1 500 ± 50 ppm analyzed hydrogen sulfide (H_2S) gas in air.

7.2.2 Other wastewater gases may be incorporated into standard practice (reference Note 1).

7.2.3 Gas(es) shall be commercially purchased with accompanied assay.

8. Wastewater Testing Chamber

8.1 The testing apparatus consists of the following:

8.1.1 *Glass Tank*—Minimum diameter 40.64 cm x 30.48 cm (16 in x 12 in) tall. The glass tank, when fitted with a polypropylene lid (tank cover) and elastomeric seal, creates an air-tight test chamber. The glass tank is inert to the aggressive reagents at the testing temperature. The glass tank shall be translucent to permit visual examination of the test specimens throughout specified testing duration.

8.1.2 *Polypropylene Lid*—Octagon shaped, minimum 2.54 cm (1 in) thick x 45.72 cm (18 in) span. The polypropylene lid has a 3.81 cm (1.5 in) diameter center port to accommodate a polypropylene shaft. The shaft slides through an O-ring seal which is secured and tensioned with a polypropylene fitting. The shaft slides easily up and down through the O-ring seal while preventing the release of test gases. Silicone grease lubricant can be used to facilitate movement of the shaft.

8.1.2.1 The polypropylene lid is designed with three ports for couplings which serve as inlet and outlet lines.

8.1.2.2 The polypropylene lid also includes eight holes along the exterior angles of the octagon to accommodate eight threaded rods. The eight threaded rods connect the polypropylene lid to a laminated wood base located under the glass tank to seal the glass tank, thereby creating an air-tight testing chamber.

8.1.3 *Specimen Carousel*—Constructed of polypropylene (or other suitable corrosion-resistant material) with slots so that the test specimens will rest vertically, arranged circumferentially.

8.1.3.1 The specimen carousel has an attached, perpendicular central shaft constructed of polypropylene (or other suitable corrosion-resistant material) to facilitate raising and lowering of the carousel within the chamber to the liquid phase (lowered position) or vapor phase (raised position).

8.1.3.2 When the specimen carousel is in the liquid phase (lowered position) the specimen carousel, including testing specimens, must be completely immersed in the aqueous solution. When raised into the vapor phase (raised position) the aqueous solution must drain away from the test specimens through drain holes in the carousel.

8.1.4 *Gas Inlet*—A flexible and resilient polypropylene or polyethylene gas supply line connects the wastewater gas supply to a polypropylene inlet fitting on the tank cover. The inlet fitting assembly accommodates a polypropylene extension tube which runs to the bottom of the chamber. The vertical extension tube allows the wastewater gas mixture to be sparged though the aqueous solution.

8.1.4.1 Gas supply line includes a gas flow indicator to measure instantaneous and relative flow rate.

8.1.4.2 Gas supply line includes a polypropylene stopcock valve with low-friction plug of TFE.

8.1.4.3 Gas supply line includes a polypropylene gas check valve with Viton® diaphragm.

8.1.5 *Air Purge Inlet*—An external flexible and resilient polypropylene or polyethylene fresh air supply line connecting the air pump to the tank cover through a polypropylene connector.

8.1.5.1 Air supply line includes a polypropylene stopcock valve with low-friction plug of TFE.

8.1.5.2 Air supply line includes a polypropylene gas check valve with Viton® diaphragm.

8.1.6 *Gas Outlet*—An external flexible and resilient polypropylene line from the tank cover with a polypropylene connector, is connected to caustic scrubbers to capture H_2S in the effluent gases.

8.1.6.1 Outlet line includes a pressure relief valve and pressure gauge teed into the gas outlet line using Teflon® coated isolation diaphragms.

8.1.6.2 Outlet line includes a polypropylene stopcock valve with low-friction plug of TFE.

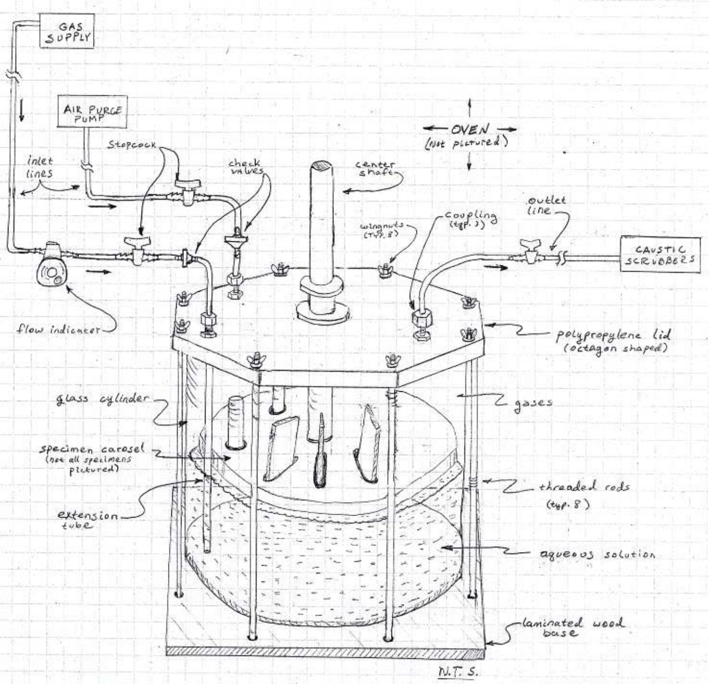

FIG. 1 Wastewater Testing Chamber

8.1.7 *Secondary Containment*—A polypropylene tray of suitable volume may be placed under the test chamber as an additional precaution against acid spillage.

8.1.8 *Oven*—Convection (forced air) oven of sufficient capacity to accommodate the test chamber and be capable of maintaining a temperature of 65° ± 3°C (150° ± 5°F). This ensures a uniform temperature throughout the chamber and testing duration.

8.1.9 *Purge Pump*—Variable-flow tubing pump to purge the test chamber and outlet lines of the hydrogen sulfide gas (and other sewer gases) at the completion of the exposure time.

8.1.9.1 Flow rates are adjustable from 0.5 to 1.5 liters per minute (L/min).

8.1.10 *Caustic Scrubbers*—Capable of removing H_2S from the exhaust test gas. A typical scrubber consists of a 4 litre polypropylene carboy, half filled with 15% sodium hydroxide (NaOH). Bubble dispersion media is added to the carboy.

8.1.10.1 "Percent" is defined as volume of solute per volume of solution. 15% NaOH contains 150 grams of sodium hydroxide per liter of solution, which is the same as 1.02 moles of sodium hydroxide per liter of solution.

8.1.10.2 Carboy cap is equipped with polypropylene fitting which accommodates a 6.35 mm (0.25 in) polyethylene inlet dip tube and outlet tube (exhaust).

8.1.10.3 The use of two or more scrubbers in series improves removal efficacy.

8.1.11 *Fume Hood*—Ventilation apparatus of sufficient capacity to encase the oven and provide necessary negative air flow to evacuate the surrounding air of any fugitive gas emissions.

8.1.12 *Gas Sensors*—Hydrogen sulfide sensors and other pertinent safety monitors to ensure operator safety.

9. Operating Procedure

9.1 *Preparations of the Wastewater Testing Chamber:*

9.1.1 Add the aqueous solution to the glass tank.

9.1.2 Insert the test specimens into the respective slots of the specimen carousel.

9.1.3 Place the specimen carousel into the glass tank in the vapor phase (raised position).

9.1.4 Fit the polypropylene lid with an elastomeric seal made of Viton$^{®}$ (or other suitable material) onto the glass tank.

9.1.5 Add the o-ring sealing fitting. Tighten the central o-ring seal on the polypropylene lid.

9.1.6 Seal the polypropylene lid to the glass tank with the eight threaded rods that run between the laminated wooden base and polypropylene lid. Wing nuts and washers are used to evenly tension the seal in the lid to create an air tight chamber. CAUTION: Tighten the wingnuts in such a way that pressure is applied evenly between the lid and glass tank in order to avoid cracking the glass.

9.1.7 Connect the inlet and outlet lines.

9.1.8 Check the air-tight seal of the test chamber by pumping air into the chamber. CAUTION: Do NOT over-pressurize the chamber.

9.1.9 Place the wastewater chamber into the convection oven.

9.1.10 Turn on the oven and allow the wastewater chamber to achieve testing temperature. (This normally takes 1 to 1.5 hours).

9.2 *Testing Procedure:*

9.2.1 Lower the test specimens into the aqueous solution for 15 minutes. Following the 15 minute immersion period, raise the carousel to the vapor phase (raised position).

9.2.2 Initiate flow of the test gas directing the exhaust gases through the caustic scrubbers. Continue to purge the test chamber with the test gas delivered at a rate of 1 to 1.5 liters per minute (lpm) for 2 hours. Then terminate gas supply and close the inlet and outlet stopcock valves.

9.2.3 The test panels are immersed two more times for 15 minutes after the gas sparge is complete.

9.2.4 This completes day 1, cycle 1 testing.

9.3 *Testing Procedure for Subsequent Weekdays*:

9.3.1 At the first of each subsequent weekday open the outlet valve and lower the test specimens into the liquid phase (lowered position) for a period of 15 minutes. Following the 15 minute period, raise the carousel to the vapor phase (raised position).

9.3.2 Purge the test chamber with the wastewater gas delivered at a rate of 1 to 1.5 lpm for 2 hours. Then terminate gas flow and close the inlet and outlet stopcock valves.

9.3.3 Raise the carousel with panels to the vapor phase (raised position).

9.3.4 Immerse the test panels two more times for a period of 15 minutes each at 3 hour intervals (± 1 hrs) for each working day and return to the vapor phase (raised position).

9.3.5 Repeat the cycle testing for each working weekday for the 28 day testing duration.

9.4 *Testing Procedure for Weekends:*

9.4.1 During the weekend the test specimens are left in the vapor phase (raised position) of the test chamber and are not to be immersed during this time. The oven remains on at the prescribed temperature.

9.5 *Completion of the 28 day (Note 3) test*:

9.5.1 At the completion of the testing duration a total of 60 immersions and 20 gas purges are completed.

9.5.2 Turn off the oven.

Open the outlet stopcock valve and initiate fresh air flow using the air purge pump (flow rate approximately 1 to 1.5 L/minute) to flush the test gas from the chamber. Continue the fresh air purge until the chamber is cool and the hydrogen sulfide has been reduced below one ppm. (This may take several hours).

9.5.3 Check the effluent air with appropriate gas detectors to ensure the levels are within pertinent safety limits.

9.5.4 Open the oven door and disassemble the test chamber.

9.5.5 Remove the test specimens and rinse with tap water.

9.5.6 Proceed with testing procedure in accordance with procedures in Section 10.

Note 3—Periodic EIS testing may be performed to obtain additional EIS permeation data (i.e. 10 d, 20 d). Total exposure time is to be extended accordingly to equal 28 day chamber exposure; see also Note 2.

10. Testing Procedure: *Steel Specimens* (See Ref. and Appendix[7])

10.1 Label and photograph each test panel (including the front and back).

10.2 Evaluate the color and appearance of the specimens and describe the coating (i.e., rough, smooth, irregular). Notate any coating abnormalities.

10.3 Measure dry-film-thickness (DFT) of the steel panels in accordance with ASTM D 7091.

10.4 Perform visual inspection of the panels:

10.4.1.1 *Blistering*—Rated using ASTM D 714.

10.4.1.2 *Rusting*—Rated using ASTM D 610.

10.4.1.3 *Checking*—Rated using ASTM D 660.

10.4.1.4 *Cracking*—Rated using ASTM D 661.

10.4.2 Perform Electrochemical Impedance Spectroscopy (EIS) Analysis:

10.4.2.1 Procedure (ISO 16773 Parts 1 and 2)—Measure the impedance of each steel specimen before and after exposure to test conditions. The pre-test is a baseline, against which post-run values are compared to assess the chemico-physical changes in the coating, which can reflect deterioration and increased permeability. The specific procedure for the EIS Analysis is as follows:

10.4.2.1.1 Attach an acrylic tube 3.81 cm (1.5 in) diameter to the coated steel specimen with silicone adhesive.

10.4.2.1.2 Fill the acrylic tube with 5% NaCl solution and cover with a stopper. Condition the specimen for 48 hours at 24°C (75°F).

10.4.2.1.3 Following conditioning measure the impedance from 0.001 Hz to 100 kHz.

10.4.2.1.4 Read the impedance at 0.001 Hz ($Z_{0.001\ Hz}$ $\Omega\ cm^2$) by interpolation and calculate the impedance corrected to a 1 cm^2 (0.4 in^2) area.

10.4.2.1.5 Single measurements are made for each coated steel specimen.

10.4.2.1.6 The Log Z value at 0.001 Hz is tabulated and used as the basis of comparison between coatings. Decreases in impedance are commonly associated with a loss in barrier properties and increased permeability. An interpretation technique is presented in Appendix X2.

10.4.3 Adhesion Analysis:

10.4.3.1 Direct Tensile Adhesion. ASTM D 4541 with scoring around the dolly. Triplicate tests (pulls) performed per steel specimen and the average tensile strength (per panel) reported.

10.4.3.2 Parallel Scribe Adhesion. Make two parallel cuts 3-6 mm (1/8-1/4 in) apart by 5 cm (2 in) long through the coating to the steel substrate. A utility knife is used to evaluate the adhesion by prying at the coating at 5 randomly selected points along the scribe. Adhesion is assessed using the following scale:

10.4.3.2.1

Rating	Description
A	No disbondment
B	>50% still attached
C	<50% still attached
D	No adhesion
F	Disbondment outside scribed lines

11. Testing Procedure: *Concrete Specimens*

11.1 Label and photograph each test specimen.

11.2 Evaluate the color and appearance of the specimens and describe the coating (i.e., rough, smooth, irregular). Notate any coating abnormalities.

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[7] Refer to appendix and references at the end of this standard.

11.3 Parallel Scribe Adhesion: Make two parallel cuts, longitudinally, 3-6 mm (1/8-1/4 in) apart by 5 cm (2 in) long through the coating to the concrete substrate. A utility knife is used to evaluate the adhesion by prying at the coating at 5 randomly selected points along the scribe. Adhesion is assessed using the following scale:

11.3.1

Rating	Description
A	No disbondment
B	>50% still attached
C	<50% still attached
D	No adhesion
F	Disbondment outside scribed lines

11.4 Optical Microscopy:

11.4.1 Mechanically cut a cross section of the concrete specimen at a randomly selected point across the axis of the specimen.

11.4.2 Place cross section under a digitally enhanced microscope with a calibrated reticule.

11.4.3 Randomly select an area along the circumference of the cross section for microscopic examination of the film.

11.4.4 Make a minimum 5 measurements. Report the average of the readings per testing specimen.

11.4.4.1 Measure the total dry film thickness of the coating under the microscope using the calibrated reticule.

11.4.4.2 Measure the rate of permeation of the coating on basis of color change within the film.

12. Testing Procedure: *Mechanical Specimens*

12.1 Evaluate the color and appearance of the specimens and describe the coating (rough, smooth, irregular, etc.). Notate any coating abnormalities.

12.2 Carry out the respective mechanical test for control samples and samples which have been exposed to the wastewater testing chamber in accordance with respective ASTM testing procedures.

12.2.1 Tensile Strength Testing, ASTM

12.2.2 Flexural Strength Testing, ASTM

12.3 Report the specific ASTM methods used for evaluation.

13. Reproducibility of Coating Performance

13.1 The results of any test of a specific coating should be reproducible each time the coating is tested under identical test conditions. If reproducibility is not achieved, further investigation must be made either by a detailed evaluation of the sample or by retesting.

14. Hazards

14.1 Caution: This practice can be extremely hazardous. Extreme caution needs to be taken when working with hydrogen sulfide gas, sulfuric acid and any other gases incorporated into the wastewater testing chamber. It is highly recommended that this procedure only be performed by a professional testing laboratory with experience and provisions for safe handling of these dangerous gas(es) and reagents.

15. Report

15.1 Report the following:

15.1.1 Name of Protective Coatings Manufacturer

15.1.2 Product Trade Name / Designations:

15.1.2.1 Concrete Resurfacer

15.1.2.2 Primer (if applicable)

15.1.2.3 Intermediate coat (if applicable)

15.1.2.4 Topcoat

15.1.3 Surface Preparation:

15.1.3.1 Steel Test Specimens

15.1.3.2 Concrete Test Specimens

15.1.4 Dry-Film Thickness:

15.1.4.1 Steel Test Specimens

15.1.4.2 Concrete Test Specimens

15.1.5 *Permeability:*

15.1.5.1 EIS

15.1.5.1.1 Pre-test

15.1.5.1.2 Post-test

15.1.5.2 Optical Microscopy

15.1.6 *Physical Testing:*

15.1.6.1 Adhesion

15.1.6.1.1 Tensile Adhesion Steel

15.1.6.1.2 Parallel Scribe Adhesion Steel

15.1.6.1.3 Parallel Scribe Adhesion Concrete

15.1.6.2 Tensile Strength

15.1.6.3 Flexural Strength

15.1.7 *Visual Testing:*

15.1.7.1.1 Blistering

15.1.7.1.2 Rusting

15.1.7.1.3 Cracking

15.1.7.1.4 Checking

16. Keywords

16.1 Wastewater; severe wastewater analysis test; accelerated testing; hydrogen sulfide gas; biogenic sulfide corrosion; protective coatings; protective linings; wastewater gases.

APPENDIX

(Nonmandatory Information)

X1. SAMPLE FORM

Rapid Evaluation of Coatings and Linings by Severe Wastewater Analysis Test

Manufacturer:
Address:
City, State, Zip:
Contact:

Product Trade Name:
Product Generic Description:

Surface Preparation:
Steel
Concrete

Resurfacer (if applicable):
Primer (if applicable):

RESULTS OF ANALYSIS

Dry-Film Thickness (DFT):	Control	Sample 1	Sample 2	Sample 3	
Steel Specimens					
Concrete Specimens					
Permeability	Control	Sample 1	Sample 2	Sample 3	
Steel Specimens					
Electrochemical Impedance Spectroscopy (EIS)		*Log Z* *(@0.001Hz)*			
					Avg.
Concrete Specimens					
Optical Microscopy					
Permeation	N/A				
% Permeation	N/A				Grand Avg.
Physical Testing	Control	Sample 1	Sample 2	Sample 3	
Steel Specimens					
Tensile Adhesion					Grand Avg.
Parallel Scribe Adhesion					Grand Avg.
Concrete Specimens					
Parallel Scribe Adhesion					Grand Avg.

Tensile Strength	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
Control Specimens							
						Grand Avg.	
S.W.A.T. Specimens							
						Grand Avg.	
Flexural Strength	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
Control Specimens							
						Grand Avg.	
S.W.A.T. Specimens							
						Grand Avg.	

Visual Testing				
Steel Specimens	Control	Sample 1	Sample 2	Sample 3
Blistering (ASTM D 714)				
Rusting (ASTM D610)				
Checking (ASTM D 660)				
Cracking (ASTM D 661)				

Name of Laboratory:
City, State, Country
Name of Engineer:

Date of Sample Receipt:
Date of Report:
Name of Responsible Manager:

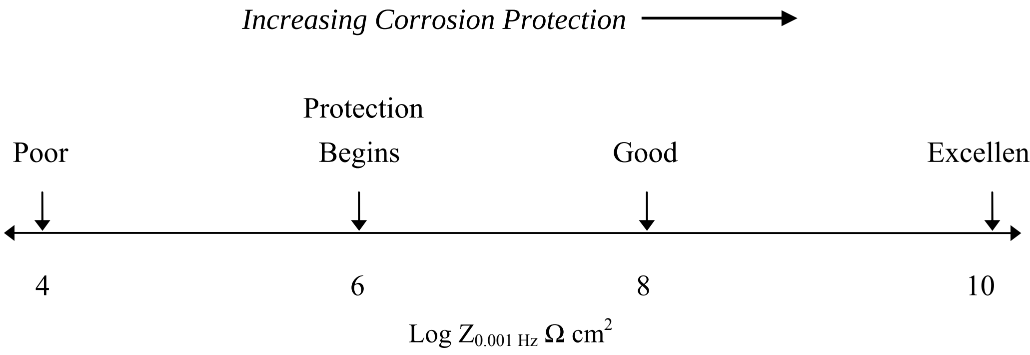
X2. NOTES ON THE INTREPREATION TECHNIQUE

X2.1 Experimentally, the impedance of a coating is determined as a function of the frequency of an applied AC voltage. The data consist of a Bode plot of Log Z verses Log f, where Z is impedance in ohms$\cdot$cm^2 and f is frequency in Hertz (0.001 Hz to 100 kHz). From the Bode plot, Log $Z_{0.001\ \mathrm{Hz}}$ is determined by interpolation. The Log Z value at 0.001 Hz can be tabulated and used as the basis of comparison between coatings and for monitoring the change of a coating as a function of exposure time to the test environment.

X2.2 Selection of Log $Z_{0.001\ \mathrm{Hz}}$ is somewhat arbitrary but represents a compromise between speed of analysis and the selection of a frequency at which differences in coating performance can be reliably determined.

X2.3 Interpretation of the impedance data relative to barrier protection is in accordance with the following logarithmic scale of Coating Impedance, Log $Z_{0.001\ \mathrm{Hz}}$ Ω cm^2:

X2.3.1



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This Standard Practice is subject to revision at any time.

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