Designation: A775/A775M – 22

Standard Specification for Epoxy-Coated Steel Reinforcing Bars[1]

This standard is issued under the fixed designation A775/A775M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers deformed and plain steel reinforcing bars with protective epoxy coating applied by the electrostatic spray method.

NOTE 1—The coating applicator is identified throughout this specification as the manufacturer.

1.2 Other organic coatings may be used provided they meet the requirements of this specification.

1.3 Requirements for coatings are contained in Annex A1.

1.4 Requirements for patching material are contained in Annex A2.

1.5 Guidelines for construction practices at the job-site are presented in Appendix X1.

1.6 This specification is applicable for orders in either inch-pound units (as Specification A775) or SI units [as Specification A775M].

1.7 The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.8 *This standard 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 safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A944 Test Method for Comparing Bond Strength of Steel Reinforcing Bars to Concrete Using Beam-End Specimens

A996/A996M Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

A1035/A1035M Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement

B117 Practice for Operating Salt Spray (Fog) Apparatus

D374/D374M Test Methods for Thickness of Solid Electrical Insulation

D2967 Test Method for Corner Coverage of Powder Coatings

D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

E2937 Guide for Using Infrared Spectroscopy in Forensic Paint Examinations

G8 Test Methods for Cathodic Disbonding of Pipeline Coatings

G14 Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)

G20 Test Method for Chemical Resistance of Pipeline Coatings

G62 Test Methods for Holiday Detection in Pipeline Coatings

2.2 *NACE Standards:*[3]

RP-287-87 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surface Using a Replica Tape

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from NACE International (NACE), 1440 South Creek Dr., Houston, TX 77084-4906, http://www.nace.org.

***A Summary of Changes section appears at the end of this standard**

2.3 *SSPC Specifications:*[4]
SSPC-PA 2 Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-SP 10 Near-White Blast Cleaning
SSPC-VIS 1 Pictorial Surface Preparation Standards for Painting Steel Surfaces
2.4 *CRSI Documents:*[5]
"Voluntary Certification Program for Fusion Bonded Epoxy Coating Applicator Plants"
2.5 *ACI Standards:*[6]
ACI 301 Specifications for Structural Concrete

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *conversion coating, n*—preparation of the blast-cleaned steel surface prior to coating application that is designed to pretreat the metal to promote coating adhesion, reduce metal-coating reactions, improve corrosion resistance, and increase blister resistance.

3.1.2 *disbonding, n*—loss of adhesion between the fusion-bonded epoxy coating and the steel reinforcing bar.

3.1.3 *fusion-bonded epoxy coating, n*—product containing pigments, thermosetting epoxy resins, crosslinking agents, and other additives, which is applied in the form of a powder onto a clean, heated metallic substrate and fuses to form a continuous barrier coating.

3.1.4 *holiday, n*—discontinuity in a coating that is not discernible to a person with normal or corrected vision.

3.1.5 *patching material, n*—liquid two-part epoxy coating used to repair damaged coating and to coat uncoated areas on the surface of a coated bar.

3.1.6 *wetting agent, n*—material that lowers the surface tension of water allowing it to penetrate more effectively into small discontinuities in the coating, giving a more accurate indication of the holiday count.

4. Ordering Information

4.1 Orders for epoxy-coated steel reinforcing bars under this specification shall contain the following information:

4.1.1 Specification and year of issue for the reinforcing bars to be coated (5.1),

4.1.2 Quantity of bars,

4.1.3 Size and grade of bars, and

4.1.4 ASTM designation A775 [A775M] and year of issue.

4.2 The purchaser shall have the option to specify additional requirements, including but not limited to the following:

4.2.1 Requirements for review of test data to demonstrate that the powder coating meets Annex A1 (5.2),

4.2.2 Representative sample of epoxy powder coating (5.3),

4.2.3 Quantity of patching material (5.4.4),

4.2.4 Specific requirements for test frequency (9.1),

4.2.5 A report of the results of the tests performed on the coated steel reinforcing bars (14.1),

4.2.6 Requirements for inspection (12.1),

4.2.7 Manufacturer qualification and certification requirements (if any), and

4.2.8 Other special requirements, if any.

NOTE 2—It is recommended that the coating application procedures and processes be audited by an independent certification program for epoxy coating applicator plants such as that provided by the Concrete Reinforcing Steel Institute, or equivalent.

NOTE 3—Deformed Grade 60 bars to ASTM A615 – _____; 20 000 ft, No. 6, 40 ft 0 in. long in secured lifts with sufficient spacers or padding, or both; epoxy-coated to ASTM A775 – _____; including written certifications for the powder coating and coated bars, and 1 qt of patching material.

[A typical ordering description is as follows: Deformed Grade 420 bars to ASTM A615M – _____; 6000 m, No. 19, 12 m long in secured lifts with sufficient spacers or padding, or both; epoxy-coated to ASTM A775M – _____; including written certifications for the powder coating and coated bars, and 1 L of patching material.]

5. Materials

5.1 Steel reinforcing bars to be coated shall meet the requirements of one of the following specifications: A615, A706, A996, or A1035 [A615M, A706M, A996M, or A1035M], as specified by the purchaser and shall be free of contaminants such as oil, grease, or paint.

NOTE 4—Prior to coating, the steel reinforcing bars should be inspected for their suitability for coating. Bars with sharp edges on the deformations, rolled-in slivers, or other surface imperfections are difficult to coat properly and should not be coated. The coating will flow away from the sharp edges and may result in inadequate coating thickness at these points.

5.2 The powder coating shall meet the requirements of Annex A1. Upon request, the purchaser shall be provided with the test report for review.

5.2.1 A written certification shall be furnished to the purchaser that properly identifies the number of each lot of powder coating used in the order, material quantity represented, date of manufacture, name and address of the powder coating manufacturer, and a statement that the supplied powder coating is the same composition as that qualified according to Annex A1 of this specification.

5.2.2 The powder coating shall be stored in a temperature-controlled environment following the written recommendations of the powder coating manufacturer until ready for use. At that point, if the storage temperature is below the plant ambient temperature, the powder coating shall be given sufficient time to reach approximate plant ambient temperature. The powder coating shall be used within the powder coating manufacturer's written recommended shelf life.

5.3 If specified in the order, a representative 8-oz [0.2-kg] sample of the powder coating shall be supplied to the purchaser from each batch. The sample shall be packaged in an airtight container and identified by batch number.

5.4 Patching material for repairing damaged coating and uncoated areas shall be inert in concrete and feasible for repairs at the applicator plant or at the fabricating shop.

5.4.1 The powder coating manufacturer shall specify the approved patching material to be used with their powder.

[4] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.

[5] Available from Concrete Reinforcing Steel Institute (CRSI), 933 North Plum Grove Rd., Schaumburg, IL 60173–4758, http://www.crsi.org.

[6] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

5.4.2 Patching material shall be approved in accordance with Annex A2 in this specification prior to use.

5.4.3 The patching material manufacturer shall specify the method of metal surface preparation, and the procedures for application of the patching material.

5.4.4 If specified in the order, patching material shall be supplied to the purchaser.

6. Surface Preparation

6.1 The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive blast cleaning to near-white metal in accordance with SSPC-SP 10. Additional surface treatment, as indicated in 6.3, is permitted.

6.1.1 Use of SSPC-VIS 1 as a visual standard of comparison to define the final surface condition is permitted.

6.1.2 Average blast profile maximum roughness depth readings of 1.5 to 4.0 mils [0.04 to 0.10 mm], as determined by replica tape measurements using NACE RP-287-87, shall be considered suitable as an anchor pattern.

NOTE 5—The use of a "profilometer" type surface measurement instrument that measures the peak count as well as the maximum profile depth is recommended.

NOTE 6—Abrasive blast cleaning of steel reinforcing bars with a high degree (>90 %) of grit in the cleaning media provides the most suitable anchor profile for coating adhesion. After grit has been recycled, a small portion will take on the appearance of shot.

6.2 Multidirectional, high-pressure dry air knives shall be used after blasting to remove dust, grit, and other foreign matter from the blast-cleaned steel surface. The air knives shall not deposit oil on the steel reinforcing bars.

NOTE 7—It is recommended that incoming steel reinforcing bars and blast media be checked for salt contamination prior to use. Blast media found to be salt contaminated should be rejected. Steel reinforcing bars found to be salt contaminated from exposure to deicing salts or salt spray should be cleaned by acid washing or other suitable methods to remove salt contaminants from the surface prior to blast cleaning.

6.3 It shall be permissible for the manufacturer to use a chemical wash or conversion of the blast-cleaned steel reinforcing bar surface, or both, to enhance coating adhesion. This pretreatment shall be applied after abrasive cleaning and before coating, in accordance with the written application instructions specified by the pretreatment manufacturer.

7. Coating Application

7.1 If pretreatment is used in the preparation of the surface, the powder coating shall be applied to the cleaned and pretreated steel reinforcing bar surface as soon as possible after surface treatments have been completed, and before visible oxidation of the surface occurs as discernible to a person with normal or corrected vision. In no case shall application of the coating be delayed more than 3 h after cleaning.

7.2 The fusion-bonded epoxy powder coating shall be applied in accordance with the written recommendations of the manufacturer of the powder coating for initial steel surface temperature range and post application curing requirements. During continuous operations, the temperature of the surface immediately prior to coating shall be measured using infrared guns or temperature indicating crayons, or both, at least once every 30 min.

NOTE 8—The use of infrared and temperature-indicating crayon measurement of the steel reinforcing bars is recommended.

7.3 The powder coating shall be applied by electrostatic spray or other suitable method.

8. Requirements for Coated Steel Reinforcing Bars

8.1 *Coating Thickness:*

8.1.1 The coating thickness measurements after curing shall be 7 to 12 mils [175 to 300 µm] for bars sizes Nos. 3 to 5 [Nos. 10 to 16] and 7 to 16 mils [175 to 400 µm] for bar sizes Nos. 6 to 18 [Nos. 19 to 57]. The upper thickness limit shall not apply to repaired areas of damaged coating.

8.1.2 A single recorded steel reinforcing bar coating thickness measurement is the average of three individual gage readings obtained between four consecutive deformations. A minimum of five recorded measurements shall be taken approximately evenly spaced along each side of the test specimens (a minimum of ten recorded measurements per bar).

8.1.3 For acceptance purposes, the average of all recorded coating thickness measurements shall not be less than the specified minimum thickness or more than the specified maximum thickness. No single recorded coating thickness measurement shall be less than 80 % of the specified minimum thickness or more than 120 % of the specified maximum thickness.

8.1.4 Measurements shall be made in accordance with SSPC-PA 2, following the instructions for calibration and use recommended by the thickness gage manufacturer. Pull-off or fixed probe gages shall be used. "Pencil-type" pull-off gages that require the operator to observe the reading at the instant the magnet is pulled from the surface shall not be used.

8.1.5 The coating thickness shall be measured on the body of a straight length of steel reinforcing bar between the deformations.

8.2 *Coating Continuity:*

8.2.1 The manufacturer's plant shall have an operational in-line 67.5 V, 80 000 Ω, wet-sponge type direct-current holiday detector or equivalent method with an automated holiday counting system to determine the acceptability of the epoxy-coated steel reinforcing bars prior to shipment.

8.2.2 If in-line detector or equivalent method is inoperable or unavailable, an off-line holiday detector or handheld detector shall be permitted provided that 100 % of the epoxy-coated steel reinforcing bars are tested and all holiday counts are recorded.

NOTE 9—Handheld holiday detector checks should be performed each production day to verify the accuracy of the in-line system. Handheld holiday detectors offer a reliable way to correlate data obtained from the in-line holiday detector and automated counting system.

8.2.3 On average, there shall not be more than 3 holidays per metre [one holiday per foot] on a coated steel reinforcing bar. The average applies to the full production length of a bar.

8.2.4 A wetting agent shall be used in accordance with Test Methods G62 in the inspection for holidays on the coated steel reinforcing bars.

8.3 *Coating Flexibility:*

8.3.1 The coating flexibility shall be evaluated by bending production coated steel reinforcing bars at a uniform rate

around a mandrel of specified size within a maximum specified time period as prescribed in Table 1. The two longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius. The test specimens shall be between 68 °F and 86 °F [20 °C and 30 °C].

8.3.2 Cracking or disbonding of the coating on the outside radius of the bent bar visible to a person with normal or corrected vision shall be considered cause for rejection of the coated steel reinforcing bars represented by the bend test sample.

NOTE 10—The qualification requirements for coating flexibility (see A1.3.6.1) prescribe bending a No. 6 [No. 19] deformed bar around a 6-in. [150-mm] diameter mandrel. The bend test requirements in Table 1 for evaluating the coating flexibility of production-coated steel reinforcing bars, for bar sizes Nos. 3 to 8 [Nos. 10 to 25], are not compatible with fabrication bending practices. Finished bend diameters for bar sizes Nos. 3 to 8 [Nos. 10 to 25] used in actual construction are smaller than the mandrel diameters in Table 1. Thus, the finished bends of production-coated bars, particularly the smaller bar sizes used for stirrups and ties, should be examined closely for hairline cracking on the outside radius of the bent bar. If hairline cracking is present, it should be repaired with patching material.

8.3.3 A test in which fracture or partial failure of the steel reinforcing bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test occurs, shall be considered an invalid test and the test shall be repeated on a new specimen.

8.4 The requirements for coated steel reinforcing bars shall be met at the manufacturer's plant prior to shipment.

9. Number of Tests

9.1 The purchaser shall have the option to specify the sampling and test schedule for the number and frequency of tests for coating thickness, continuity, and flexibility.

9.2 If the number and frequency of tests are not specified by the purchaser the following apply:

9.2.1 Tests for coating thickness shall be made on a minimum of two bars of each size every two production hours,

9.2.2 Bend tests for coating flexibility shall be conducted on at least one bar of each size every four production hours, and

TABLE 1 Bend Test Requirements

A615, A706, A996, or A1035		A615M, A706M, A996M, or A1035M		Bend Angle (After Rebound, degrees)	Time to Completion max, s
Bar No.	Mandrel Diameter, in.[A]	Bar No.	Mandrel Diameter, mm[A]		
3	3	10	75	180	15
4	4	13	100	180	15
5	5	16	125	180	15
6	6	19	150	180	15
7	7	22	175	180	45
8	8	25	200	180	45
9	9	29	230	180	45
10	10	32	250	180	45
11	11	36	280	180	45
14	17	43	430	90	45
18	23	57	580	90	45

[A] Mandrel diameters specified for similar size (shown on the same line) inch-pound and metric bars may be interchanged.

9.2.3 Random tests shall be made for coating continuity.

10. Retests

10.1 If the specimen for coating thickness or flexibility fails to meet the specified requirements, two retests on random samples shall be conducted for each failed test. If the results of both retests meet the specified requirements, the coated steel reinforcing bars represented by the samples shall be accepted.

11. Permissible Amount of Damaged Coating and Repair of Damaged Coating

11.1 The maximum amount of repaired damaged coating shall not exceed 1 % of the total surface area in each 1-ft [0.3 m] of the bar. This limit on repaired damaged coating shall not include sheared or cut ends that are coated with patching material (see 11.4).

11.2 All damaged coating due to fabrication and handling (to the point of shipment to the job-site) shall be repaired with patching material conforming to Annex A2.

NOTE 11—If the amount of repaired damaged coating in any 1-ft [0.3-m] length of a coated bar, exceeds 1 %, that section should be removed from the coated steel reinforcing bar and discarded. In patching damaged coating , care should be taken not to apply the patching material over an excessive area of the intact coating during the repair process. Too large an area of thick patching material especially on smaller-size reinforcing bars is likely to cause a reduction in bond strength of the bars to concrete.

11.3 Repaired areas shall have a minimum coating thickness of 7 mils [175 µm].

11.4 When coated bars are sheared, saw-cut, or cut by other means during the fabrication process, the cut ends shall be coated with patching material. Coated steel reinforcing bars shall not be flame cut.

11.5 Repair of damaged coating shall be performed in accordance with the patching material manufacturer's written recommendations.

12. Inspection

12.1 Inspection of the epoxy-coated steel reinforcing bars shall be agreed upon between the purchaser and the manufacturer as part of the purchase order or contract.

13. Rejection

13.1 Coated steel reinforcing bars represented by test specimens that do not meet the requirements of this specification shall be rejected and marked with a contrasting color paint or other suitable identification. At the manufacturer's option, the affected lot shall be replaced or, alternatively, stripped of coating, recleaned, recoated, and resubmitted for acceptance testing in accordance with the requirements of this specification.

NOTE 12—If the coating is not to be stripped from the rejected steel reinforcing bars, the bars should be scrapped or with the purchaser's approval used as uncoated steel reinforcing bars.

14. Certification

14.1 The purchaser shall be furnished with, at the time of shipment, written certification that samples representing each

lot of coated steel reinforcing bars have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

14.2 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document must meet the requirements of the invoked ASTM standard(s) and conform to any EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 13—The industry definition invoked here is: EDI is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

15. Handling and Identification

15.1 All systems for handling coated steel reinforcing bars shall have padded contact areas. All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All bundles of coated steel reinforcing bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar-to-bar abrasion from sags in the bundles of coated steel reinforcing bars. The bars or bundles shall not be dropped or dragged.

15.2 If circumstances require storing coated steel reinforcing bars outdoors for more than two months, protective storage measures shall be implemented to protect the material from sunlight, salt spray and weather exposure. If the manufacturer stores coated steel reinforcing bars outdoors without protective covering, the date on which the coated bars are placed outdoors shall be recorded on the identification tag on the bundled steel. Coated steel reinforcing bars, whether individual bars or bundles of bars, or both, shall be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked bundles, the protective covering shall be draped around the perimeter of the stack. The covering shall be secured adequately, and allow for air circulation around the bars to minimize condensation under the covering.

15.3 Coated steel reinforcing bars, whether individual bars or bundles of bars, or both, shall be stored off the ground on protective cribbing.

15.4 The identification of all steel reinforcing bars shall be maintained throughout the coating and fabrication processes to the point of shipment.

16. Keywords

16.1 coating requirements; concrete reinforcement; corrosion resistance; epoxy coating; steel bars

ANNEXES

(Mandatory Information)

A1. REQUIREMENTS FOR ORGANIC COATINGS FOR STEEL REINFORCING BARS

A1.1 Powder Coatings

A1.1.1 This annex covers qualification requirements for barrier organic coatings for protecting steel reinforcing bars from corrosion.

A1.1.2 The powder coating shall be of organic composition except for the pigment which may be inorganic if used.

A1.2 Test Materials

A1.2.1 A 1-lb [0.5-kg] sample of the powder coating with its generic description and its infrared spectrum shall be submitted to the testing agency. The infrared spectrum shall be obtained with Fourier Transform Infrared Spectroscopy (FTIR) using Guide E2937. The spectrum and generic description shall become an integral part of the qualification test report.

NOTE A1.1—The infrared spectrum uniquely identifies the powder sample.

A1.2.2 A sample of patching material conforming to Annex A2 shall be submitted to the testing agency. The product name and a description of the patching material shall be given in the test report.

A1.2.3 *Test Specimens:*

A1.2.3.1 The following specimens shall be submitted as a minimum for test:

(1) Fourteen 4-ft [1.2-m] long No. 6, Grade 60 [No. 19, Grade 420] deformed steel reinforcing bars, with a coating thickness of 7 mils to 12 mils [175 μm to 300 μm],

(2) Six uncoated and uncleaned No. 6 [No. 19] steel reinforcing bars, 4-ft [1.2-m] long, and from the same lot of steel as the coated bars,

(3) Four 4 in. by 4 in. by 0.05 in. [100 mm by 100 mm by 1.3 mm] steel plates with center holes for Taber abrasers coated to a thickness of 10 mils ± 2 mils [250 μm ± 50 μm].

(4) Four free films of coating material with a thickness of 7 mils to 9 mils [175 μm to 225 μm]. The films shall be at least 4 in. by 4 in. [100 mm by 100 mm].

(5) Fourteen coated No. 6 [No. 19] steel reinforcing bars, 10-in. [0.25-m] long, coated to a thickness of 7 mils to 12 mils [175 μm to 300 μm]. The coated steel reinforcing bars shall have their ends sealed with patching material.

A1.2.3.2 Steel reinforcing bars with a nominal diameter within ±0.04 in. [±1 mm] of No. 6 [No. 19] bars shall be acceptable for qualification testing.

A1.2.3.3 The coating on the bars and films tested shall be free of holes, voids, contamination, cracks and damaged areas. The coated bars shall be checked for holidays using a 67.5-V, 80 000-Ω, wet-sponge type dc holiday detector in accordance with Test Methods G62. The total number of holidays found on the bar specimens tested shall be reported.

A1.2.3.4 Coating thickness measurements shall be made in accordance with 8.1.

A1.2.3.5 The manufacturer shall specify the method and grade of metal surface preparation and the coating application procedures for the test specimens and for contract production of coated steel reinforcing bars. These procedures shall be listed in the test report.

NOTE A1.2—Production-coated steel reinforcing bars will be required to be manufactured in the same manner as the qualification bars. Therefore, it is necessary that the qualification bars be prepared in the manner proposed for production. Variations in the critical preparation, thermal treatment, and coating procedures known to be allowable without a compromise in quality should also be detailed in the qualification report.

A1.3 Coating Requirements

A1.3.1 *Infrared Spectroscopy (IR)*—Variations in the gel and cure time of the powder coatings shall be permitted, if the resulting powder spectrum is comparable to the reference spectrum of the original powder that was submitted for initial qualification. Differences between powders are indicated by the presence or absence of one or more absorption peaks or significant differences in shape or position (frequency) of the bands in the spectra. The reference and sample spectra are considered to represent the same material when the position of corresponding peaks in the two spectra are within plus/minus 5 cm^{-1}. The IR test shall be performed using the FTIR. The spectral range should cover at least 4000 cm^{-1} to 650 cm^{-1}. Samples being compared shall be prepared in the same manner (for example, KBr, cast film, ATR,) as the reference material and the IR scans shall be obtained using equivalent parameters. Spectral differences associated with sample concentration (the overall level of transmittance or absorbance across the entire spectrum of the sample or other effects unrelated to the composition such as incidental presence of atmospheric peaks) shall not be considered as non-conforming differences when making the comparison.

A1.3.2 *Chemical Resistance*—The chemical resistance of the coating shall be evaluated in accordance with Test Method G20 by immersing coated steel reinforcing bars in each of the following: distilled water, a 3 *M* aqueous solution of $CaCl_2$, a 3 *M* aqueous solution of NaOH, and a solution saturated with $Ca(OH)_2$. Specimens without holidays and specimens with intentional holes drilled through the coating 0.25 in. [6 mm] in diameter shall be tested. The temperature of the test solutions shall be 75 °F ± 3.6 °F [24 °C ± 2 °C]. Minimum test time shall be 45 days. The coating must not blister, soften, lose bond, nor develop holidays during this period. The coating surrounding the intentionally made holes shall exhibit no undercutting during the 45-day period.

A1.3.3 *Cathodic Disbondment*—Test Methods G8 shall be followed except:

A1.3.3.1 The cathode shall be a 10-in. [250-mm] long coated steel reinforcing bar;

A1.3.3.2 The anode shall be a 6-in. [150-mm] long solid platinum electrode (0.06 in. [1.6 mm] nominal diameter) or platinized wire (0.125 in. [3.2 mm] nominal diameter);

A1.3.3.3 A calomel reference electrode shall be used;

A1.3.3.4 The electrolyte solution shall be 3 % NaCl by mass dissolved in distilled water;

A1.3.3.5 The electrolyte solution temperature shall be 75 °F ± 3.6 °F [24 °C ± 2 °C];

A1.3.3.6 The drilled coating defect shall be 0.12 in. [3 mm] in diameter;

A1.3.3.7 A potential of −1.5 V measured against the calomel reference electrode shall be applied and a 10-Ω shunt resistor used; and

A1.3.3.8 The test duration shall be 168 h.

A1.3.3.9 Fig. A1.1 presents the recommended equipment configuration for performing cathodic disbondment testing on straight steel reinforcing bars. The intentional coating defect shall be placed approximately 2 in. [50 mm] from the sealed end of the test bar centered between the longitudinal and transverse ribs. It shall be drilled just deep enough to expose a full 0.12 in. [3 mm] diameter in the steel. The test bar shall be inserted with the sealed end of the bar resting on the bottom of the test vessel and electrolyte added until 4 in. [100 mm] of the bar length is submerged.

A1.3.3.10 The tested bars shall be allowed to cool for approximately 1 h ± 0.25 h prior to evaluation. Four measurements shall be taken at 0°, 90°, 180°, and 270° and the values averaged. The average coating disbondment radius of three coated steel reinforcing bars shall not exceed 0.16 in. [4 mm] when measured from the edge of the intentional coating defect.

A1.3.4 *Salt Spray Resistance*—The resistance of the coating to a hot, wet corrosive environment shall be evaluated in accordance with Practice B117 by exposing 10 in. [250 mm] long coated steel reinforcing bars containing intentional defects to 95 °F ± 3.6 °F [35 °C ± 2 °C] salt spray comprised of 5 % NaCl by mass dissolved in distilled water for 800 h ± 20 h. Three intentional 0.12 in. [3 mm] diameter defects shall be

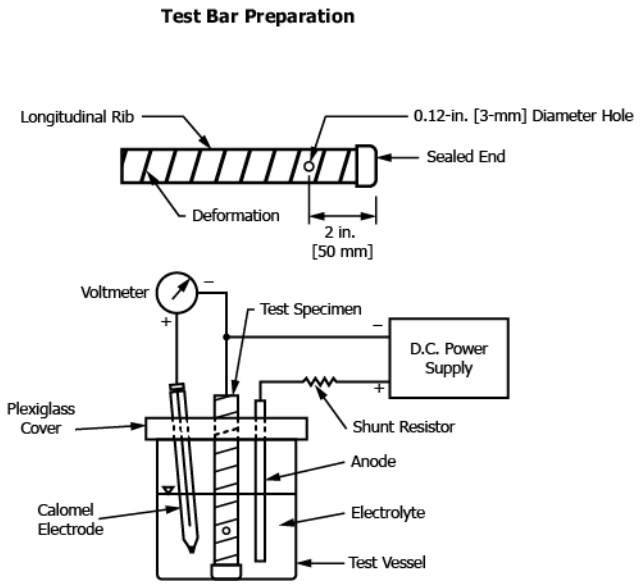


FIG. A1.1 Cathodic Disbondment Test Equipment Configuration

drilled through the coating of each test specimen approximately evenly spaced along one side of the bar with the holes centered between deformations. The coated steel reinforcing bars shall be placed horizontally in the cabinet with the damage sites facing the side (90°). The test specimens shall be allowed to cool for approximately 1 h ± 0.25 h prior to evaluation. Four measurements shall be taken, at 0°, 90°, 180°, and 270° and the values averaged. The average coating disbondment radius of nine test sites on three coated steel reinforcing bars shall not exceed 3 mm [0.12 in.] when measured from the edge of the intentional coating defect.

A1.3.5 *Chloride Permeability*—The chloride permeability characteristics of the cured coating having a film thickness of 7 mils to 9 mils [175 µm to 225 µm] shall be measured on two test films and a control film at 75 °F ± 3.6 °F [24 °C ± 2 °C] for 45 days. The permeability cells shall be of the type shown in Fig. A1.2. Films selected for testing shall be carefully handled and examined for any defects prior to installation in the cell. The cell shall consist of two glass compartments separated by a coating film sandwiched between two glass plates, each having a centered 1-in. [25-mm] hole. One compartment shall contain 5.3 oz [175 mL] of 3*M* NaCl and the other 3.5 oz [115 mL] of distilled water. The activity of chloride ions passing through the film shall be measured using a specific ion meter equipped with a chloride electrode and a double junction reference electrode. Activity measurements shall be converted into concentration values of mole per *M* [L] with a conversion diagram, constructed by plotting measured chloride ion activities versus known chloride ion concentrations. The accumulative concentration of chloride ions permeating through the film shall be less than $1 \times 10^{-4} M$.

A1.3.6 *Coating Flexibility:*

A1.3.6.1 The coating flexibility shall be evaluated by bending three coated steel reinforcing bars 180° (after rebound) around a 6-in. [150-mm] diameter mandrel. The bend shall be made at a uniform rate and completed within a 15-s time period. The two longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius and the specimen shall be at 75 °F ± 3.6 °F [24 °C ± 2 °C].

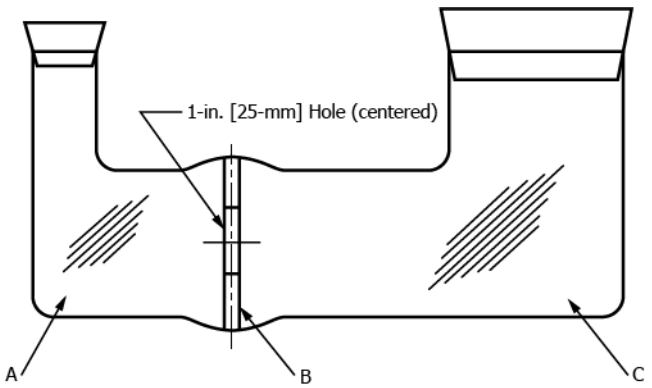
A1.3.6.2 No cracking of the coating shall be visible to a person with normal or corrected vision on the outside radius of any of the three bent bars.

A1.3.6.3 A test in which fracture or partial failure of the steel reinforcing bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test occurs, shall be considered an invalid test and the test shall be repeated on a new specimen.

A1.3.7 *Relative Bond Strength in Concrete*—The relative bond strength of the steel reinforcing bars to concrete shall be determined with beam-end specimens by the method described in Test Method A944 using No. 6 [No. 19] steel reinforcing bars with a relative rib area (ratio of projected rib area normal to the bar axis to the product of the nominal bar perimeter and the center-to-center rib spacing) between 0.075 and 0.085. The bars shall be bottom-cast and shall have a cover of 40 mm ± 2 mm [1.5 in. ± 0.06 in.], a lead length of 0.5 in. ± 0.12 in. [13 mm ± 3 mm], and a bonded length of 10 in. ± 0.25 in. [250 mm ± 5 mm]. Test bars shall be oriented so that the longitudinal ribs and direction of rolling, relative to the direction of the applied tension, are the same for coated and uncoated bars. The test bars must be pulled in the same direction with respect to the direction of rolling. Three to six coated bar specimens and three to six uncoated bar specimens shall be tested. All steel reinforcing bars in a test group shall be from the same steel heat. The uncoated bars shall be cleaned only by lightly wiping with acetone or other suitable solvent. The mean bond strength of the coated bars shall not be less than 85 % of the mean bond strength of the uncoated bars.

A1.3.8 *Abrasion Resistance*—The resistance of the coating on each of three steel panels to abrasion by a Taber abraser (Test Method D4060) or its equivalent, using CS-10 wheels and a 2.2-lb [1-kg] load per wheel, shall be such that the weight loss shall not exceed 0.0035 oz [100 mg]/1000 cycles.

A1.3.9 *Impact Test*—The resistance of the steel reinforcing bar coating to mechanical damage shall be determined by the falling weight test. A test apparatus similar to that described in Test Method G14 shall be used along with a 4-lb [1.8-kg] tup having a nose diameter of 0.63 in. [16 mm]. Impact shall occur on the low-lying areas on the coated steel reinforcing bars, that is, between deformations or ribs. The test shall be performed at 75 °F ± 3.6 °F [24 °C ± 2 °C]. With an impact of 80 in.·lbf [9 Nm], no shattering, cracking, or bond loss of the coating shall occur except at the impact area, that is, the area permanently deformed by the tup.



Permeability Cell Components:
A. Component containing distilled water
B. Epoxy film sandwich between two glass plates each having a centered 1-in. [25-mm] diameter hole
C. Component containing 3M NaCl

FIG. A1.2 Chloride Permeability Test Equipment Configuration

A1.4 Qualification Testing

A1.4.1 *Testing Agency*—Qualification tests shall be performed by an agency acceptable to the purchaser.

A1.5 Certification

A1.5.1 A report summarizing the results of all tests and bearing the signature of the testing laboratory shall be furnished to the manufacturer.