Designation: A933/A933M – 14

Standard Specification for Vinyl-Coated Steel Wire and Welded Wire Reinforcement[1]

This standard is issued under the fixed designation A933/A933M; 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.

1. Scope*

1.1 This specification covers plain and deformed steel wire and plain and deformed steel welded wire reinforcement with protective vinyl (polyvinyl chloride, or polyvinyl chloride powder compound) coating. A Class A minimum coating thickness is required for wire and welded wire reinforcement intended for use in concrete and masonry. A Class B minimum coating thickness is required for wire and welded wire reinforcement intended for use in mechanically stabilized earth applications.

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

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

1.3 Requirements for coatings are contained in Annex A1.

1.4 Requirements for patching materials are contained in Annex A2.

1.5 The text of this specification contains notes or footnotes, or both, that provide explanatory material. Such notes and footnotes, excluding those in tables or figures, do not contain any mandatory requirements.

1.6 This specification is applicable for orders in either inch-pound units (as Specification A933) or in SI units [as Specification A933M].

1.7 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. 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.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A775/A775M Specification for Epoxy-Coated Steel Reinforcing Bars

A884/A884M Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

B117 Practice for Operating Salt Spray (Fog) Apparatus

D374 Test Methods for Thickness of Solid Electrical Insulation (Withdrawn 2013)[3]

D2240 Test Method for Rubber Property—Durometer Hardness

D2967 Test Method for Corner Coverage of Powder Coatings

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

G8 Test Methods for Cathodic Disbonding of Pipeline Coatings

G12 Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel (Withdrawn 2013)[3]

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

G20 Test Method for Chemical Resistance of Pipeline Coatings

2.2 *National Association of Corrosion Engineers Standards:*[4]

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

TM-01-70 Visual Standard for Surfaces of New Steel Air Blast Cleaned with Sand Abrasive (NACE No. 2)

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is under 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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from National Association of Corrosion Engineers (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**

TM-01-75 Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Shot or Steel Grit (NACE No. 2)

2.3 *Steel Structures Painting Council Specifications:*[5]

SSPC-PA2 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

SSPC-Vis 2 Standard Methods of Evaluating Degree of Rusting on Painted Steel Surfaces

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *conversion coating, n*—a 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 vinyl coating and the steel reinforcement.

3.1.3 *fusion-bonded vinyl coating, n*—a product containing pigments, thermoplastic vinyl resin, and other additives. It is applied in the form of a powder on a clean, heated, metallic substrate and fuses to form a continuous barrier coating.

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

3.1.5 *patching material, n*—a liquid vinyl coating used to repair damaged or uncoated areas.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification. Such requirements shall include but are not limited to the following:

4.1.1 Name of material (vinyl-coated steel wire or welded wire reinforcement),

4.1.2 Wire or welded wire reinforcement specification (5.1),

4.1.3 Wire size, if wire reinforcement,

4.1.4 Wire spacing and sizes, if welded wire reinforcement,

4.1.5 Length and width of sheets or rolls,

4.1.6 Quantity,

4.1.7 Class of coating,

4.1.8 Requirements for material samples (5.3),

4.1.9 Requirements for patching material (5.4),

4.1.10 Requirements for visual standards for surface cleaning comparison (6.1),

4.1.11 Specific requirements for test frequency (9.1),

4.1.12 Requirements for inspection of manufacturing plant (12.1), and

4.1.13 ASTM designation and year of issue.

5. Materials

5.1 Plain or deformed steel wire or welded wire reinforcement to be coated shall meet the requirements of Specification A1064/A1064M and shall be free of surface contaminants such as oil, grease, or paint when received at the manufacturer's plant and prior to cleaning and coating.

5.2 The coating material shall meet the requirements listed in Annex A1. In addition to the requirements of Annex A1, the coating material shall have demonstrated long-term stability when embedded in concrete.

5.2.1 A written certification shall be furnished to the purchaser that properly identifies the number of each batch of coating material used in the order, material quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of Annex A1.

5.3 If specified in the order, a representative 8-oz [0.20-kg] sample of the coating material 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 shall be compatible with the coating, inert in concrete, and feasible for repairs at the applicator plant or the fabricating shop. Patching material shall be approved in accordance with Annex A2 prior to use.

5.4.1 The patching material manufacturer shall specify the metals surface preparation and the procedures for application of the patching material.

5.4.2 If specified in the order, patching material conforming to Annex A2 and recommended by the powder coating manufacturer shall be supplied to the purchaser.

NOTE 2—When subjected to temperatures above 390°F [200°C] for a prolonged period of time, a vinyl coating is subject to decomposition. One of the products of decomposition is hydrochloric acid, HCl, which can damage concrete and reinforcing steel. Even in small amounts, HCl will accelerate corrosion of steel.

NOTE 3—Vinyl-coated wire has very low bond strength to concrete, and the use of deformed wire provides no advantage over plain wire. The bond strength of vinyl-coated welded wire reinforcement is similar to that of uncoated plain welded wire reinforcement since the cross wires provide the primary bond.

6. Surface Preparation

6.1 The surface of the steel wire or welded wire reinforcement 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. Any of the following visual standards of comparison shall be used to define the final surface condition: SSPC-Vis 1, SSPC-Vis 2, NACE TM-01-70, and NACE TM-01-75. 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 4—Abrasive blast cleaning of wire and welded wire reinforcement 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.

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

6.2 Multidirectional, high-pressure, dry air knives shall be used after blasting to remove dust, grit, and other foreign

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

matter from the steel surface. The air knives shall not deposit oil on the steel reinforcement.

NOTE 6—It is recommended that incoming wire and welded wire reinforcement and blast media should be checked for salt contamination prior to use. Blast media found to be salt contaminated should be rejected. Wire and welded wire reinforcement 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 reinforcement 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. Application of Coating

7.1 The coating shall be applied to the cleaned surface as soon as possible after cleaning, and before oxidation of the surface occurs discernible to a person with normal or corrected vision. However, in no case shall application of the coating be delayed more than 4 h after cleaning.

7.2 To achieve a chemical bond of the vinyl coating to metal, the steel wire or welded wire reinforcement shall be primed with appropriate primer as recommended by the manufacturer of the primer and vinyl powder compound.

7.3 The coating shall be applied and fully fused in accordance with the written recommendations of the manufacturer of the coating material.

8. Requirements for Coated Wire or Welded Wire Reinforcement

8.1 *Thickness of Coating:*

8.1.1 *Class A*—The film thickness of the coating after fusing shall be 7 to 17 mils [175 to 425 µm] for both plain and deformed steel wire and welded wire reinforcement used for concrete reinforcement. Thickness measurements below 7 mils [175 µm] shall be considered cause for rejection. The upper film thickness limits do not apply to repaired areas of damaged coating.

8.1.2 *Class B*—The film thickness of the coating after fusing shall be a minimum of 18 mils [450 µm], for both plain and deformed steel wire and welded wire reinforcement used for earth reinforcement, such as mechanically stabilized embankments. Thickness measurements below 18 mils [450 µm] shall be considered cause for rejection or reclassification as Class A if the thickness meets the Class A requirements.

8.1.3 A single recorded coating thickness measurement is the average of three individual gauge readings obtained approximately evenly spaced along each side of the coated wire or welded wire reinforcement test specimen. A minimum of five recorded measurements shall be taken approximately evenly spaced along each side of the test specimen (a minimum of 10 recorded measurements per test specimen). No individual gauge reading shall be taken closer than 0.5 in. [13mm] from an intersection.

8.1.4 For acceptance purposes, the average of all 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.

8.1.5 Measurements shall be made in accordance with SSPC-PA2 following the instructions for calibration and use recommended by the thickness gauge manufacturer. Pull-off or fixed-probe gauges shall be used. Pencil-type pull-off gauges that require the operator to observe the reading at the instant the magnet is pulled from the surface shall not be used.

8.2 *Continuity of Coating:*

8.2.1 There shall not be more than an average of one holiday per foot [three holidays per metre] on the coated wire (spool and individual lengths).

8.2.2 In welded wire reinforcement, there shall not be more than an average of one holiday per foot [three holidays per metre] in each wire direction. Voids (uncoated areas due to the faraday cage effect and weld spurs) at welded intersections shall not be counted. Damage at cut ends shall not be counted.

8.2.3 Holiday checks to determine acceptability of the wire or welded wire reinforcement shall be made at the manufacturer's plant with a 67½-V, 80 000 Ω, wet-sponge-type d-c holiday detector.

NOTE 7—Holiday detection is not intended for use at the job-site.

8.3 *Bend Test—Coating Requirement:*

8.3.1 The adhesion of the coating shall be evaluated by bending production coated steel wire and welded wire reinforcement at a uniform rate 180° around a mandrel of specified size as prescribed in Table 1. The test specimens shall be at thermal equilibrium between 68° and 86°F [20 and 30°C].

8.3.2 Cracking or disbonding of the coating on the outside radius or wrinkling of the coating on the inside radius of the bent wire or welded wire reinforcement visible to a person with normal or corrected vision shall be considered cause for rejection of the coated wire or welded wire reinforcement represented by the bend test specimen.

8.4 *Place of Testing*—Testing of coated steel wire or welded wire reinforcement shall be done at the manufacturer's plant prior to shipment.

8.5 *Time of Testing*—The requirements for coated wire or welded wire reinforcement shall be met at the manufacturer's plant prior to shipment.

TABLE 1 Bend Test Requirements

Wire Size No. W or D, in.	Wire Size No. MW or MD, mm	Mandrel Diameter	Time to Completion, s (maximum)
1.4 to 6	9 to 39	Two times the diameter of the tested wire	15
>6	>39	Four times the diameter of the tested wire	45

9. Number of Tests

9.1 The purchaser may specify the sampling and test schedule for the number and frequency of tests for coating thickness, adhesion, and continuity.

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

9.2.1 Tests for coating thickness and continuity shall be made at the manufacturer's plant on a minimum of 1 linear ft [0.3 m] of each size wire or welded wire reinforcement coated from each 2 h of production.

9.2.2 Bend tests for coating adhesion shall be conducted at the manufacturer's plant on at least one wire of each size or one style of welded wire reinforcement from each 2 h of production.

10. Retests

10.1 If the specimen for coating thickness, continuity, or adhesion fails to meet the specified requirements, two retests on random specimens shall be conducted for each failed test. If the results of both retests meet the specified requirements, the coated material represented by the specimens shall be accepted.

11. Handling and Identification

11.1 All systems for handling coated reinforcement shall have padded contact areas. Bundling bands shall be padded, or suitable banding shall be used to prevent damage to the coating. Bundles of coated reinforcement shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge. The bundled reinforcement shall be transported with care and stored off the ground on protective cribbing. The coated reinforcement shall not be dropped or dragged.

11.2 If circumstances require storing coated wire or welded wire reinforcement outdoors for more than two months, protective storage measures shall be implemented to protect the coated reinforcement from sunlight, salt spray, and weather exposure. If the manufacturer stores coated wire or welded wire reinforcement outdoors without protective covering, the date on which the coated reinforcement is placed outdoors shall be recorded on its identification tag. Coated wire or welded wire reinforcement, whether individual pieces or bundles of pieces, 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 coated reinforcement to minimize condensation under the covering.

12. Inspection

12.1 The inspector representing the purchaser shall have free entry, at all times, to the parts of the manufacturer's coating line that concern the manufacture of the coated wire or welded wire reinforcement ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the coated wire or welded wire reinforcement is being furnished in accordance with this specification. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the coating line. At a mutually agreed upon frequency, the purchaser or the purchaser's representative shall be permitted to take coated specimens from the production run for testing.

13. Permissible Coating Damage Due to Handling and Processing

13.1 Prior to shipment, all visible damaged coating on each wire and welded wire reinforcement shall be repaired with patching material.

13.2 All uncoated areas that result from hanging or supporting coated wire or welded wire reinforcement shall be patched.

13.3 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 wire. This limit shall not include sheared or cut ends that are coated with patching material (13.4).

13.4 When coated wire or welded wire reinforcement is sheared, saw-cut, or cut by other means, the cut ends shall be coated with patching material. Coated wire or welded wire reinforcement shall not be flame cut.

13.5 Patching shall be done in accordance with the patching material manufacturer's written recommendations.

14. Rejection

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

15. Certification

15.1 At the time of shipment the purchaser shall be furnished written certification that specimens representing each lot of coated steel reinforcement have been either tested or inspected as required by 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.

15.2 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 existing 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 8—The industry definition as invoked here is: EDI is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

16. Keywords

16.1 coating requirements; concrete reinforcement; corrosion resistance; steel wire; vinyl coating; welded wire reinforcement

ANNEXES

(Mandatory Information)

A1. REQUIREMENTS FOR ORGANIC COATINGS FOR PLAIN AND DEFORMED STEEL WIRE AND WELDED WIRE REINFORCEMENT

A1.1 Coating Material

A1.1.1 This annex covers qualification requirements for barrier organic coatings for protecting steel wire and welded wire reinforcement from corrosion.

A1.1.2 Material qualification tests prescribe the use of reinforcing bars and steel substrates other than wire and welded wire reinforcement for convenient comparison to pre-established procedures. This protocol follows the standards for epoxy-coated reinforcing steel products.

A1.2 Test Materials

A1.2.1 A 1-lb [0.45-kg] sample of the coating material with its generic description and fingerprint (including the method such as infrared spectroscopy or thermal analysis) shall be submitted to the testing agency. The fingerprint and generic description shall become an integral part of the qualification test report.

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) Six 4-ft [1.2-m] long No. 6 [19] deformed steel reinforcing bars, Grade 60 [420], coated with a film thickness of 7 to 12 mils [175 to 300 µm] for bend and impact tests.

(2) Two 4-ft [1.2 m] long, cleaned but uncoated No. 6 [19], deformed steel reinforcing bars, Grade 60 [420], from the same lot of steel and subject to the same cleaning process as the coated bars for instrument calibration.

(*3*) Twelve 10-in. [0.25-m] long, No. 6 [19] deformed reinforcing steel bars, Grade 60 [420], coated with a film thickness of 7 to 12 mils [175 to 300 µm], for chemical resistance and applied voltage tests. Seal the ends of the coated bars with patching material.

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

(*5*) Four free film samples of coating material 4 by 4 in. [100 by 100 mm] with a film thickness of approximately 7 mils [175 µm], for the chloride permeability test.

(*6*) Four free films of coating material, 4 by 4 in. [100 by 100 mm], approximately 30 mils [760 µm] thick, for Durometer hardness testing.

A1.2.3.2 After fusion, the coating shall be free of holidays (pinholes not visible to the unaided eye), holes, voids, contamination, cracks, and damaged areas discernible to the unaided eye. The coatings shall be checked for holidays using a 67½-V, 80 000 Ω, wet-sponge-type d-c holiday detector, and patched accordingly. The number of holidays shall be reported.

A1.2.3.3 The steel reinforcing bars shall be uniformly coated with a deviation not exceeding ±2 mils [±50 µm] from the average thickness. The thickness of the coating shall be measured on the body of the bar between the deformations or ribs.

A1.2.3.4 Coating thickness measurements shall be made in accordance with Test Method G12 as described in 8.1.3 of this specification.

A1.2.3.5 The specified number of thickness measurement readings on steel reinforcing bars shall be taken between consecutive deformations as described in 8.1.3 of this specification.

A1.2.3.6 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 wire and welded wire reinforcement. These procedures shall be listed in the test report.

A1.3 Coating Requirements

A1.3.1 *Chemical Resistance*—The chemical resistance of the coating shall be evaluated in accordance with Test Method G20 by immersing coated 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 ± 3.6°F [24 ± 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.

A1.3.2 *Cathodic Disbondment*—Test Method G8 shall be followed except:

A1.3.2.1 The cathode shall be a 10-in. [250-mm] long coated steel reinforcing bar;

A1.3.2.2 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);

A1.3.2.3 A calomel reference electrode shall be used;

A1.3.2.4 The electrolyte solution shall be 3 % NaCl by mass dissolved in distilled water;

A1.3.2.5 The electrolyte solution temperature shall be 75 ± 3.6°F [24 ± 2°C];

A1.3.2.6 The drilled coating defect shall be 0.12 in. [3 mm] in diameter;

A1.3.2.7 A potential of −1.5 V measured against the calomel reference electrode shall be applied and a 10–Ω shunt resistor used; and

A1.3.2.8 The test duration shall be 168 h.

A1.3.2.9 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.

A1.3.2.10 The tested bars shall be allowed to cool for approximately 1 ± 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 0.20 in. [5 mm] when measured from the edge of the intentional coating defect.

A1.3.3 *Chloride Permeability*—The chloride permeability characteristics of the fused coating having the minimum thickness proposed for use shall be measured on two test films and a control film at 75 ± 3.6°F [24 ± 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 6 oz [175 mL] of 3*M* NaCl and the other 4 oz [115 mL] of distilled water. The activity of chloride ions passing through the film shall be measured using a specific ion meter equipped

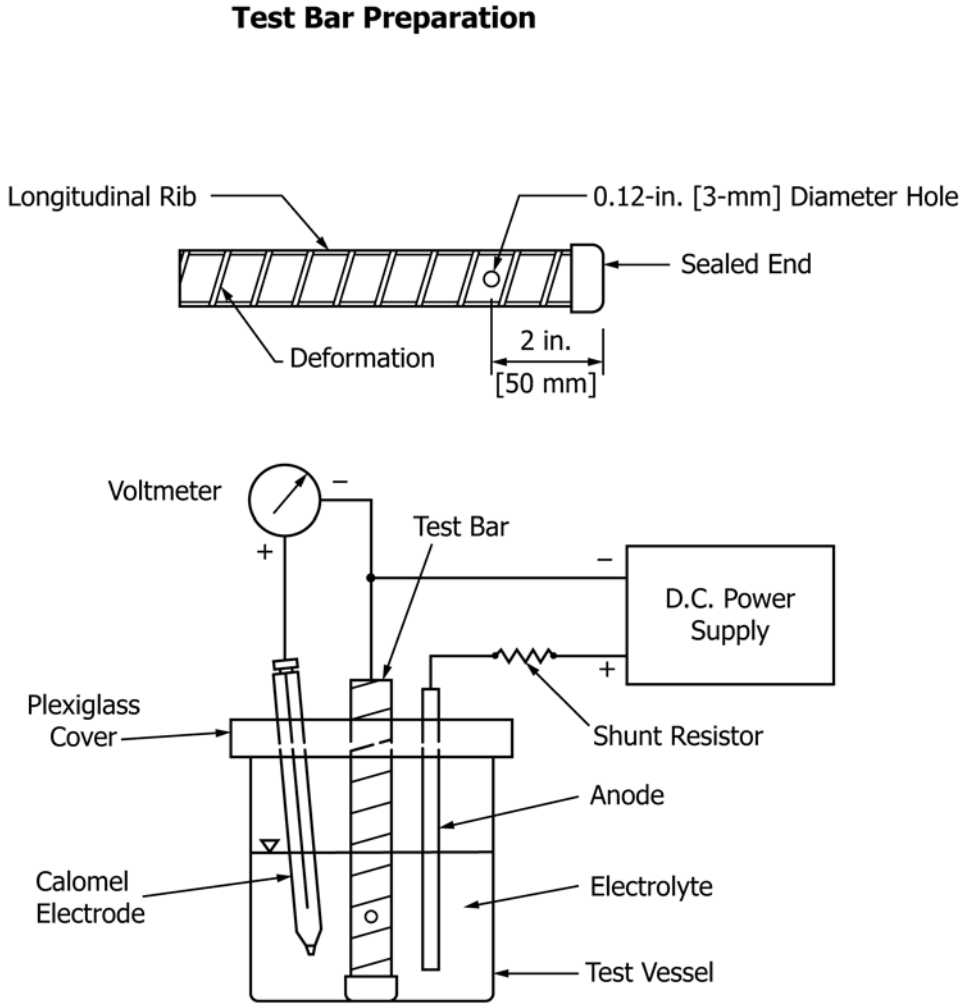
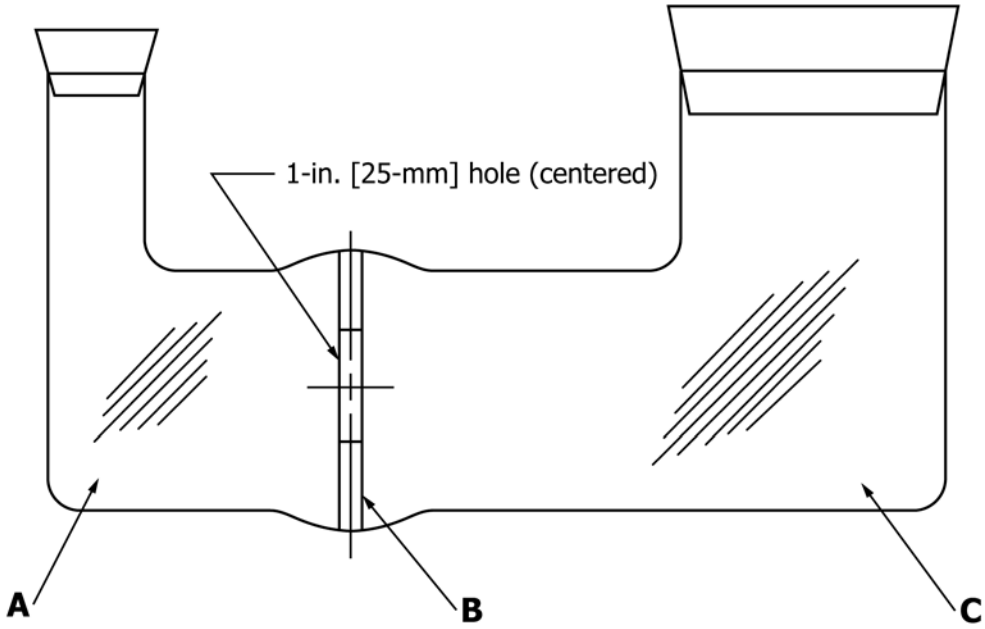


FIG. A1.1 Cathodic Disbondment Test Equipment Configuration



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

FIG. A1.2 Chloride Permeability Test Equipment Configuration

with a chloride electrode and a double junction referenced electrode. Activity measurements shall be converted into concentration values of mole per L [*M*] 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 $1 \times 10^{-4} M$.

A1.3.4 *Adhesion and Flexibility of Coating:*

A1.3.4.1 The adhesion of the coating shall be evaluated by bending three coated reinforcing bars, as specified in A1.2.3.1 (1), 180° (after rebound) around a 6-in. [150-mm] diameter mandrel. The bends shall be made at a uniform rate and completed within a 15-s time period. The two longitudinal deformations should be placed in a plane perpendicular to the mandrel radius. The specimens shall be at thermal equilibrium of 75 ± 4°F [24 ± 2 °C].

A1.3.4.2 No cracking or disbonding of the coating shall be visible on the outside radius of any of the three bent bars when examined in a well-lighted area.

A1.3.5 *Abrasion Resistance*—The resistance of a coating on each of the steel panels to abrasion by a Taber abraser (see 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 0.00355 oz [100 mg] per 1000 cycles.

A1.3.6 *Impact Test*—The resistance of the 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 ⅝ in. [16 mm]. Impact shall occur on a coated steel test panel in accordance with A1.2.3.1(4). The test shall be performed at 75 ± 3.6°F [24 ± 2°C]. With an impact of 80 in.-lb [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.

A1.3.7 *Hardness Test*—The hardness of the coating shall be determined in accordance with Test Method D2240, on durometer hardness. The average of five individual (15-s) hardness measurements shall be made and shall be equal to or exceed Shore D of 40.

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.

A2. REQUIREMENTS FOR PATCHING MATERIAL USED TO REPAIR ORGANIC COATINGS FOR STEEL WIRE AND WELDED WIRE REINFORCEMENT

A2.1 Scope

A2.1.1 This annex covers qualification requirements for patching materials that are used to repair barrier organic coatings such as vinyl coatings.

A2.2 Coating Patching Material

A2.2.1 The coating patching material shall be of organic composition except for the pigment and fillers which may be inorganic if used.

A2.2.2 A minimum of 1 qt [0.95 L] of patching material, compatible with the coating and inert in concrete, shall be submitted to the testing agency. The material shall be feasible for repairing damaged vinyl coating. The product name and a description of the patching material shall be given in the test report. A list of powder coating materials (product names and manufacturers), for which the patching material has been approved for use, shall be provided and included in the qualification test report.

A2.3 Test Specimens

A2.3.1 The following test specimens shall be submitted as a minimum for test:

A2.3.1.1 Four free films of coating patching material with a thickness within ±2 mils [±50 μm] of the patching material manufacturer's minimum recommended patching material coating application thickness.

A2.3.1.2 Six 3 by 6 by ⅛ in. [75 by 150 by 3 mm] flat steel panels that have been blast-cleaned and coated on both sides with 7 to 12 mils [175 to 300 μm] of vinyl powder coating in accordance with the powder coating manufacturer's written instructions. The hanger marks on the panels shall be sealed with silicone or other suitable sealant.

A2.3.2 A description of the specimen preparation process for the free films and flat panel specimens (for example, the number of coats of patching material applied to the intentional coating defect to achieve the minimum required coating thickness), used in this prequalification evaluation shall be provided in the test report. The patching material manufacturer shall specify the minimum patching material coating application thickness to be used. In addition, the patching material manufacturer shall specify the method of metal surface preparation and the procedures for application of the patching material. These procedures shall be followed by the testing agency to prepare the coated metal specimens for test and shall be listed in the qualification test report.

A2.4 Patching Material Requirements

A2.4.1 *Chloride Permeability*—The chloride permeability characteristics of the patching material shall be measured on two test films and a control film at 75 ± 3.6°F [24 ± 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 6 oz [175 mL] of 3*M* NaCl and the other 4 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 electrode. Activity measurements shall be converted into concentration values of mole per L [*M*] 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 1×10^{-4} *M*.

A2.4.2 *Salt Spray Resistance*—The resistance of the patching material to a hot, wet corrosive environment shall be evaluated in accordance with Practice B117. Three coated 3 by 6 by ⅛ in. [75 by 150 mm by 3 mm] flat panels, with intentional defects repaired with the patching material, shall be exposed to 95 ± 3.6°F [35 ± 2°C] salt spray comprised of 5 % NaCI by mass dissolved in distilled water for 400 ± 10 h. Each intentional defect shall be an area of 1.5 by 1 in. [12 by 25 mm] removed from the center of one side of the coated panel using a grinding wheel or other suitable method. Dust and loose material shall be removed from the intentional defect site with a clean cloth after the coating's removal. The patching material shall be prepared for application in accordance with the written instructions of the patching material manufacturer. The patching material shall be applied with a new paint brush to the intentional defect to form a patched area of 1 by 1.5 in. [25 by 37 mm] fully covering the intentional defect. The coated panel shall be lying flat on a table during the patching material application and shall remain in such a position until the coating has cured according to the manufacturer's instructions. The patching operation and the patched panels shall be maintained at a temperature of 75 ± 3.6°F [24 ± 2°C]. The patched area coating thickness shall be within ±2 mils [±50 μm] of the patching material manufacturer's minimum recommended patching material coating application thickness. The patched panels shall be allowed to cure for a minimum of three days before placement in the salt spray apparatus. The patched area coating thickness shall be measured and reported. Upon examination after completion of the test, the patched areas on each of the three coated panels shall not be observed to have formed blisters nor have developed areas of rust from holes in the patch itself or from the patching material interface with the coated panel.

A2.4.3 *Chemical Resistance*—The ability of the patching material to resist blistering and corrosion in a solution that simulates concrete pore solution shall be evaluated in accordance with Test Method G20. Three coated 3 by 6 by ⅛ in. [75 by 150 mm by 3 mm] flat panels, with intentional defects repaired with the patching material, shall be immersed in an aqueous solution containing 0.3 *N* KOH and 0.05 *N* NaOH at 132 ± 3.6°F [55 ± 2°C] for 28 days. Each intentional defect

shall be an area of 1.5 by 1 in. [12 by 25 mm] removed from the center of one side of the coated panel using a grinding wheel or other suitable method. Dust and loose material shall be removed from the intentional defect site with a clean cloth after the coating's removal. The patching material shall be prepared for application in accordance with the written instructions of the patching material manufacturer. The patching material shall be applied with a new paint brush to the intentional defect to form a patched area of 1 by 1.5 in. [25 by 37 mm] fully covering the intentional defect. The coated panel shall be lying flat on a table during the patching material application and shall remain in such a position until the coating has cured according to the manufacturer's instructions. The patching operation and the patched panels shall be maintained at a temperature of 75 ± 3.6°F [24 ± 2°C]. The patched area coating thickness shall be within ±2 mils [±50 μm] of the patching material manufacturer's minimum recommended patching material coating application thickness. The patched panels shall be allowed to cure for a minimum of three days before placement in the simulated concrete pore solution. The patched area coating thickness shall be measured and reported. Upon examination after completion of the test, the patched areas on each of the three coated panels shall not be observed to have formed blisters nor have developed areas of rust from holes in the patch itself or from the patching material interface with the coated panel.

A2.4.4 *Edge Coverage:*

A2.4.4.1 Four precision-finished ½ by ½ by 2 in. [13 by 13 by 50 mm] steel bars, as described in Test Method D2967, Section 6.4, with edges having a radius of no more than 0.005 in. [0.13 mm] shall be prepared for the test procedure. The test specimens shall be inspected with a 10× microscope or magnifying glass prior to use to determine that all edges are of the proper sharpness and free from nicks and burrs. The test specimens shall be cleaned in a suitable solvent to remove all oil, grease and foreign matter. The test specimens shall then be air-dried.

A2.4.4.2 A 1-in. [25-mm] micrometer caliper, in accordance with Method C of Test Method D374, or other suitable instrument, shall be used to make thickness measurements. Measure and record the distance across both diagonals of each of the four test bars to the nearest 0.1 mils [2.5 μm] at a point 1.5 in. [38 mm] from the end of the specimen to be left uncoated (the top end). Average each uncoated specimen's diagonal measurements.

A2.4.4.3 Approximately 0.24 qt [0.25 L] of the patching material shall be prepared in a suitable container in accordance with the written instructions of the patching material manufacturer. The patching material shall be prepared and the test specimens shall be coated according to the application recommendations of the patching material manufacturer. After coating, the test specimens shall be cured according to the manufacturer's instructions. The patching material application operation and the patched test specimens shall be maintained at a temperature of 75 ± 3.6°F [24 ± 2°C].

A2.4.4.4 Again measure and record the distance across both diagonals of each of the four now coated test specimens to the nearest 0.1 mils [2.5 μm] at the same point 1.5 in. [38 mm] from the uncoated end of the specimen.

A2.4.4.5 Average the distance measurements across the two diagonals of the coated test bars. Subtract the average diagonal measurement of each uncoated specimen from that of each coated specimen and divide by two to obtain the average edge thickness.

A2.4.4.6 The average of the four averaged edge coating thickness measurements from the four test specimens shall be greater than or equal to the patching material manufacturer's minimum recommended patching material coating application thickness.

A2.5 Qualification Testing

A2.5.1 *Testing Agency*—Qualification tests shall be performed by an agency acceptable to the purchaser.

A2.6 Certification

A2.6.1 A report summarizing the results of all tests and bearing the certification of the testing laboratory on official company letterhead shall be furnished to the manufacturer.

APPENDIX

(Nonmandatory Information)

X1. GUIDELINES FOR JOB-SITE PRACTICES

X1.1 This specification is a product standard. Requirements for fusion-bonded vinyl-coated steel reinforcement from the point of shipment to the job-site and subsequent practices at the job-site are not delineated in this product standard.

X1.2 The project specifications should prescribe requirements for the coated steel reinforcement from the point of shipment to the job-site and subsequent practices at the job-site. In the absence of these requirements in the project specifications, the following guidelines for job-site practices are recommended:

X1.2.1 When handling coated steel reinforcement, care should be exercised to avoid bundle-to-bundle or wire-to-wire abrasion.

X1.2.2 Equipment for handling coated steel reinforcement should have protected contact areas.

X1.2.3 Coated steel reinforcement should be off-loaded as close as possible to their points of placement or under the crane so that the material can be hoisted to the area of placement to minimize rehandling.

X1.2.4 Coated steel reinforcement should be stored off the ground on protective cribbing, and timbers placed between bundles when stacking is necessary. Space the supports sufficiently close to prevent sags in the bundles.

X1.2.5 Coated and uncoated steel reinforcement should be stored separately.

X1.2.6 Long-term storage should be minimized and work stoppages phased to suit construction progress.

X1.2.7 If circumstances require storing coated steel reinforcement outdoors for more than two months, protective storage measures should be implemented to protect the material from sunlight, salt spray and weather exposure. If the coated steel reinforcement are stored outdoors without protective covering, it is recommended that the date on which the coated reinforcement are placed outdoors be recorded on the identification tag on the bundled steel. Coated steel reinforcement stored in corrosive environments may require protection sooner. Coated steel reinforcement should be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked material, the protective covering should be draped around the perimeter of the stack. The covering should be secured adequately, and allow for air circulation around the coated reinforcement to minimize condensation under the covering.

X1.2.8 When the extent of damaged coating exceeds 2 % of the surface area of the coated steel reinforcement in any 1-ft [0.3-m] length; the coated steel reinforcement should be rejected.

X1.2.9 When the extent of the damaged coating does not exceed 2 % of the surface area in any 1-ft [0.3-m] length, all damaged coating discernible to a person with normal or corrected vision should be repaired with patching material.

X1.2.10 Coated steel reinforcement should not be flame cut.

X1.2.11 Placed coated steel reinforcement should be inspected for damaged coating prior to placing concrete. Where damage exists, it should be repaired with patching material complying with this specification.

X1.2.12 Patching material should be applied in strict accordance with the written instructions furnished by the patching material manufacturer. Prior to application of the patching material, rust should be removed from the damaged areas by suitable means. The patching material should be allowed to cure before placing concrete over the coated steel reinforcement.

X1.2.13 When placing coated steel reinforcement, all wire bar supports, spacers, and tie wire should be coated with dielectric material, that is, a vinyl-coated or plastic-coated material compatible with concrete.

X1.2.14 After placing, walking on coated steel reinforcement should be minimized. The placement of mobile equipment should be planned to avoid damage to the coated material.

X1.2.15 When immersion-type vibrators are used to consolidate concrete around vinyl-coated steel reinforcement, the vibrators should be equipped with nonmetallic vibrator heads.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A993/A993M – 10) that may impact the use of this standard. (Approved May 1, 2014.)

(1) Removed referenced materials from 2.1 and 5.1.
(2) Removed Note 2, below 5.1, and renumbered subsequent notes accordingly.