Designation: A 955/A 955M – 07

Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement[1]

This standard is issued under the fixed designation A 955/A 955M; 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 deformed and plain stainless-steel bars for concrete reinforcement used in applications requiring resistance to corrosion or controlled magnetic permeability. The standard sizes and dimensions of deformed bars and their numerical designation shall be those listed in Table 1. The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.1.1 Supplementary requirement (S1) of an optional nature is provided. It shall apply only when specified by the purchaser. In order to obtain a controlled magnetic permeability product, steel conforming to Supplementary Requirement S1 should be ordered.

1.2 The chemical composition of the stainless steel alloy shall be selected for suitability to the application involved by agreement between the manufacturer and the purchaser. This is an important consideration in achieving the desired corrosion resistance and/or controlled magnetic permeability because these properties are not provided by all stainless steels..

NOTE 1—The alloys shown in Table 2 have found the most use in North America. Other alloys may also provide desired properties; consult with the manufacturer for stainless steel alloy properties and availability.

1.3 Bars are generally of three minimum yield strength levels, namely, 40 000 [300 MPa], 60 000 [420 MPa], and 75 000 psi [520 MPa], designated as Grade 40 [300], Grade 60 [420], and Grade 75 [520], respectively.

1.4 Plain rounds in sizes up to and including 2 in. [50.8 mm] in diameter, when specified for dowels, spirals, structural ties, and supports, shall be furnished under this specification in Grade 40 [300], Grade 60 [420], and Grade 75 [520], respectively. Bending properties, when required, shall be by agreement between the manufacturer and purchaser. Requirements providing for deformations and marking shall not be applicable to plain bars.

1.5 Weldability of most stainless steel compositions is generally good, however, pre-weld or post-weld procedures, or both, are necessary. Where material is to be welded, a welding procedure suitable for the chemical composition and intended use or service shall be used. Retesting of physical properties should be considered following welding procedures depending upon the steel composition and welding operation involved.

NOTE 2—It is recommended that the user consult the manufacturer for information available from the Nickel Development Institute (NIDI) (Toronto, Canada).

1.6 This specification is applicable for orders in either inch-pound units (as Specification A 955) or in SI units (as Specification A 955M).

1.7 The values stated in either inch-pound 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 are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 6/A 6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A 276 Specification for Stainless Steel Bars and Shapes

A 342/A 342M Test Methods for Permeability of Feebly Magnetic Materials

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A 510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

C 192/C 192M Practice for Making and Curing Concrete

[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.

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

TABLE 1 Deformed Bar Designation Numbers, Nominal Weights [Masses], Nominal Dimensions, and Deformation Requirements

Bar Designation No.[A]	Nominal Weight, lb/ft [Nominal Mass, kg/m][B]		Nominal Dimensions[C]			Deformation Requirements, in. [mm]		
	400 Series; Duplex Alloys	300 Series	Diameter, in. [mm]	Cross-Sectional Area, in.^{2}[mm^2]	Perimeter, in. [mm]	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12.5 % of Nominal Perimeter)
3 [10]	0.374 [0.556]	0.378 [0.562]	0.375 [9.5]	0.11 [71]	1.178 [29.9]	0.262 [6.7]	0.015 [0.38]	0.143 [3.6]
4 [13]	0.679 [1.011]	0.686 [1.021]	0.500 [12.7]	0.20 [129]	1.571 [39.9]	0.350 [8.9]	0.020 [0.51]	0.191 [4.9]
5 [16]	1.048 [1.559]	1.058 [1.575]	0.625 [15.9]	0.31 [199]	1.963 [49.9]	0.437 [11.1]	0.028 [0.71]	0.239 [6.1]
6 [19]	1.495 [2.225]	1.511 [2.248]	0.750 [19.1]	0.44 [284]	2.356 [59.8]	0.525 [13.3]	0.038 [0.97]	0.286 [7.3]
7 [22]	2.038 [3.032]	2.059 [3.064]	0.875 [22.2]	0.60 [367]	2.749 [69.8]	0.612 [15.5]	0.044 [1.12]	0.334 [8.5]
8 [25]	2.685 [3.995]	2.713 [4.037]	1.000 [25.4]	0.79 [510]	3.142 [79.8]	0.700 [17.8]	0.050 [1.27]	0.383 [9.7]
9 [29]	3.396 [5.053]	3.441 [5.106]	1.128 [28.7]	1.00 [645]	3.544 [90.0]	0.790 [20.1]	0.056 [1.42]	0.431 [10.9]
10 [32]	4.312 [6.416]	4.358 [6.484]	1.270 [32.3]	1.27 [819]	3.990 [101.3]	0.889 [22.6]	0.064 [1.63]	0.487 [12.4]
11 [36]	5.296 [7.880]	5.352 [7.964]	1.410 [35.8]	1.56 [1006]	4.430 [112.5]	0.987 [25.1]	0.071 [1.80]	0.540 [13.7]
14 [43]	7.64 [11.37]	7.72 [11.49]	1.693 [43.0]	2.25 [1452]	5.32 [135.1]	1.185 [30.1]	0.085 [2.16]	0.648 [16.5]
18 [57]	13.59 [20.22]	13.72 [20.43]	2.257 [57.3]	4.00 [2581]	7.09 [180.1]	1.58 [40.1]	0.102 [2.59]	0.864 [21.9]

† Editorial change made.

[A] Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars [bar numbers approximate the number of millimetres of the nominal diameter of the bar].

[B] The 400 and Duplex-Alloy Series is based on a density of 489.59 lb/in.^{3}[7833.4 kg/m^3]. The 300 Series is based on a density of 494.78 lb/ft^3[7916.5 kg/m^3]. Density varies with alloy content which may result in a variation of several percent.

[C] The nominal dimensions of a deformed bar are equivalent to those of a round bar having the same weight [mass] per foot [metre] as the deformed bar.

TABLE 2 Chemical Requirements of Typical Alloys[A]

UNS Designation	Type	Composition %								
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen
S24000	XM-29	0.08	11.50-14.50	0.060	0.030	1.00	17.00-19.00	2.25-3.75	....	0.20-0.40
S24100	XM-28	0.15	11.00-14.00	0.060	0.030	1.00	16.50-19.00	0.50-2.50	....	0.20-0.45
S30400	304	0.08	2.00	0.045	0.030	1.00	18.00-20.00	8.00-10.50	....	0.10
S31603	316L	0.03	2.00	0.045	0.030	1.00	16.00-18.00	10.00-14.00	2.00-3.00	0.10
S31653	316LN	0.08	2.00	0.045	0.030	1.00	16.00-18.00	10.00-14.00	2.00-3.00	0.10-0.16
S31803	....	0.03	2.00	0.045	0.020	1.00	21.00-23.00	4.50-6.50	2.50-3.50	0.08-0.20

[A] Maximum, unless otherwise indicated.

Test Specimens in the Laboratory

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

G 15 Terminology Relating to Corrosion and Corrosion Testing

2.2 *U.S. Military Standard:*[3]

MIL-STD-129 Marking for Shipment and Storage[3]

2.3 *U.S. Federal Standard:*[3]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *deformed bar*—steel bar with protrusions; a bar that is intended for use as reinforcement in reinforced concrete construction.

3.1.2 *Discussion*—The surface of the bar is provided with lugs or protrusions that inhibit longitudinal movement of the bar relative to the concrete surrounding the bar in such construction. The lugs or protrusions conform to the provisions of this specification.

3.1.3 *deformations*—transverse protrusions on a deformed bar.

3.1.4 *plain bar*—steel bar without protrusions.

3.1.5 *rib*—longitudinal protrusion on a deformed bar.

3.1.6 *stainless steel*—a steel that contains 11 % or more chromium.

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 Quantity (weight) [mass],

4.1.2 Name of material (deformed and plain stainless steel bars for concrete reinforcement),

4.1.3 Chemical composition (stainless steel alloy),

4.1.4 Heat treatment condition,

4.1.5 Size,

4.1.6 Length,

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS. Or visit: http://assist.daps.dla.mil/online.

4.1.7 Deformed or plain,
4.1.8 Grade (strength level),
4.1.9 Packaging (see Section 24),
4.1.10 Supplementary requirement (if desired), and
4.1.11 ASTM designation and year of issue.

5. Materials and Manufacture

5.1 The bars shall be rolled from properly identified heats of mold or strand cast steel.

5.2 Bars shall be furnished in one of the following heat treatment conditions, as shown in Specification A 276, and as needed to meet the requirements of this specification.

5.2.1 Annealed (A).
5.2.2 Hot rolled (HR).
5.2.3 Strain hardened (B).

NOTE 3—The mechanical properties of the material result from the heat treat condition of the material. Any further heat treatment of the material may alter those properties and affect their ability to meet the specified strength level. No re-treatment should be imposed without retesting to the requirements of this specification.

6. Chemical Composition

6.1 An analysis of each heat of steel shall be made by the manufacturer from test samples taken during the pouring or casting of the steel. Such analysis shall meet the chemical composition requirements specified in Table 2 by the purchaser.

6.2 When specified by the purchaser, an analysis of the product shall be made by the manufacturer and shall conform to the analysis tolerances specified in Table 1 of Specification A 484/A 484M.

6.3 An analysis made by the purchaser from the finished product shall meet the specification tolerances of Specification A 484/A 484M.

7. *Requirements for Deformations* Requirements for Deformations

7.1 Deformations shall be spaced along the bar at substantially uniform distances. The deformations on opposite sides of the bar shall be similar in size, shape, and pattern.

7.2 The deformations shall be placed with respect to the axis of the bar so that the included angle is not less than 45°. Where the line of deformations forms an included angle with the axis of the bar of from 45 to 70° inclusive, the deformations shall alternately reverse in direction on each side or those on one side shall be reversed in direction from those on the opposite side. Where the line of deformation is over 70°, a reversal in direction is not required.

7.3 The average spacing or distance between deformations on each side of the bar shall not exceed seven tenths of the nominal diameter of the bar.

7.4 The overall length of deformations shall be such that the gap (measured as a chord) between the ends of the deformations shall not exceed 12½ % of the nominal perimeter of the bar. Where the ends terminate in a rib, the width of the rib shall be considered as the gap between these ends. The summation of the gaps shall not exceed 25 % of the nominal perimeter of the bar. Furthermore, the summation of gaps shall not exceed 25 % of the nominal perimeter of the bar. The nominal perimeter of the bar shall be 3.1416 times the nominal diameter.

7.5 The spacing, height, and gap of deformations shall conform to the requirements prescribed in Table 1.

8. Measurement of Deformations

8.1 The average spacing of deformations shall be determined by measuring the length of a minimum of ten spaces and dividing that length by the number of spaces included in the measurement. The measurement shall begin from a point on a deformation at the beginning of the first space to a corresponding point on a deformation after the last included space. Spacing measurements shall not be made over a bar area containing bar marking symbols.

8.2 The average height of deformations shall be determined from measurements made on not less than two typical deformations. Determinations shall be based on three measurements per deformation, one at the center of the overall length and the other two at the quarter points of the overall length.

8.3 Insufficient height, insufficient circumferential coverage, or excessive spacing of deformations shall not constitute cause for rejection unless it has been clearly established by determinations on each lot (Note 4) tested that typical deformation height, gap, or spacing does not conform to the minimum requirements prescribed in Section 7. No rejection shall be made on the basis of measurements if fewer than ten adjacent deformations on each side of the bar are measured.

NOTE 4—A lot, *for this purpose*, is defined as all the bars of one bar number and pattern of deformation contained in an individual shipping release or shipping order.

9. Tensile Requirements

9.1 The material, as represented by the test specimens, shall conform to the requirements for tensile properties prescribed in Table 3 or by agreement between the manufacturer and the purchaser.

9.2 The yield strength shall be determined by reading the stress corresponding to the prescribed strain using the autographic diagram method or an extensometer as described in Test Methods and Definitions A 370 (paragraph 13.2.2). The strain shall be 0.35 %.

9.3 The percentage of elongation shall be as prescribed in Table 3. When the actual percentage of elongation meets or exceeds 25 % of the bending requirements in Section 10 shall be waived.

TABLE 3 Tensile Requirements

NOTE 1—Check with producer for availability of grades and sizes.

	Grade 40 [300]	Grade 60 [420]	Grade 75 [520]
Tensile strength, min, psi [MPa]	70 000 [500]	90 000 [620]	100 000 [690]
Yield strength, min, psi [MPa]	40 000 [300]	60 000 [420]	75 000 [520]
Elongation in 8 in. [203.2 mm], min, %:			
Bar designation no.	[280]	[420]	[520]
3, 4, 5 [10, 13, 16]	20	20	
6 [19]	20	20	20
7, 8, 9, 10, 11, 14, 18[22, 25, 29, 32, 36, 43, 57]		20	20

10. Bending Requirements

10.1 The bend test specimen shall withstand being bent around a pin without cracking on the outside radius of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table 4.

10.2 The bend test shall be made on specimens of sufficient length to ensure free bending and with apparatus which provides the following:

10.2.1 Continuous and uniform application of force throughout the duration of the bending operation,

10.2.2 Unrestricted movement of the specimen at points of contact with the apparatus and bending around a pin free to rotate, and

10.2.3 Close wrapping of the specimen around the pin during the bending operation.

10.3 It is permissable to use more severe methods of bend testing, such as placing a specimen across two pins free to rotate and applying the bending force with a fixed pin. When failures occur under more severe methods, retests shall be permitted under the bend-test method prescribed in 10.2.

11. Hardness Requirements

11.1 Martensitic grades shall meet the minimum hardness requirements shown in Specification A 276, or other referenced specifications.

12. Corrosion Resistance Requirements

12.1 The demonstration of corrosion resistance shall be by the recommended practice in Annex A1 or by agreement between the manufacturer and the purchaser.

12.2 Corrosion performance as demonstrated in Annex A1 shall be performed one time for each stainless steel alloy processed as reinforcement by each manufacturer. Corrosion performance for the alloy shall be redemonstrated if the processing method is significantly altered.

13. Magnetic Properties

13.1 Controlled magnetic permeability shall be specified by invoking Supplementary Requirement S1.

14. Permissible Variation in Weight [Mass]

14.1 Deformed reinforcing bars shall be evaluated on the basis of nominal weight [mass]. The weight [mass] determined using the measured weight [mass] of the test specimen and rounding in accordance with Practice E 29, shall be at least 94 % of the applicable weight [mass] per unit prescribed in Table 1. In no case shall overweight [excess mass] of any deformed bar be the cause for rejection. Weight [mass] variation for plain rounds shall be computed on the basis of permissible variation in diameter. For plain rounds smaller than ⅜ in. [9.5 mm], use Specification A 510 [Specification A 510M]. For larger bars up to and including 2 in. [50.8 mm], use Specification A 6/A 6M.

14.2 The specified limit of variation shall be evaluated in accordance with Practice E 29 (rounding method).

TABLE 4 Bend Test Requirements

Bar Designation No.	Pin Diameter for Bend Test[A]		
	Grade 40 [300]	Grade 60 [420]	Grade 75 [520]
3, 4, 5 [10, 13, 16]	3½ d[B]	3½ d	. . .
6 [19]	5d	5d	5d
7, 8 [22, 25]	. . .	5d	5d
9, 10, 11 [29, 32, 36]	. . .	7d	7d
14, 18 [43, 57] (90°)	. . .	9d	9d

[A] Test bends 180° unless noted otherwise.
[B] d = nominal diameter of specimen.

15. Finish

15.1 The bars shall be free of detrimental surface imperfections.

15.2 Seams, surface irregularities, or mill oxidation shall not be cause for rejection, provided the mass, dimensions, cross-sectional area, and tensile properties of a test specimen are not less than the requirements of this specification.

15.3 Surface imperfections other than those specified in 15.1 shall be considered detrimental when specimens containing such imperfections fail to conform to either tensile or bending requirements.

16. Number of Tests

16.1 For all bar sizes, one tension test, one bend test, if required (see 6.3), and one set of dimensional property tests including bar weight [mass] and spacing, height, and gap of deformations shall be made of each bar size rolled from each heat and of the same heat treatment condition.

16.2 For martensitic material, two hardness tests shall be taken per lot of material. A manufacturing lot is defined as material from one heat of material heat treated in one furnace at one time. For continuous furnaces used for tempering or aging, a manufacturing lot is defined as material from one heat of material heat treated in one continuous run but not to exceed 10 000 lbs [4500 kg].

17. Retests

17.1 If the results of an original tension specimen fail to meet the specified minimum requirements and are within 2000 psi [14 MPa] of the required tensile strength, within 1000 psi [7 MPa] of the required yield strength, or within two percentage units of the required elongation, a retest shall be permitted on two random specimens for each original tension specimen failure from the lot. All retest specimens shall meet the requirements of this specification.

17.2 If a bend test fails for reasons other than mechanical reasons or flaws in the specimen as described in 17.5.2 and 17.5.3, a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification. The retest shall be performed on test specimens that are at air temperature but not less than 60°F [16°C].

17.3 If a weight [mass] test fails for reasons other than flaws in the specimen as described in 17.5.3, a retest shall be permitted on two random specimens from the same lot. Both retest specimens shall meet the requirements of this specification.

17.4 If a corrosion resistance test fails for reasons other than flaws as described in 17.5.3, a retest shall be permitted on two

random specimens from the same lot. Both retest specimens shall meet the requirements of this specification.

17.5 If the original test or any of the random retests fails because of any reasons listed in 17.5.1, 17.5.2, or 17.5.3, the test shall be considered an invalid test:

17.5.1 The elongation property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle half of the gage length, as indicated by scribe marks on the specimen before testing,

NOTE 5—Marking specimens with multiple scribe or punch marks can reduce the occurrence of fracture outside or near these marks and the need for declaring the test invalid.

17.5.2 Mechanical reasons such as failure of testing equipment or improper specimen preparation,

17.5.3 Flaws are detected in a test specimen, either before or during the performance of the test.

17.6 The original results from sections 17.5.1, 17.5.2, or 17.5.3 shall be discarded and the test shall be repeated on a new specimen from the same lot.

18. Test Specimens

18.1 Tension test specimens shall be the full section of the bar as rolled. The unit stress shall be based on the nominal bar area.

18.2 The bend test specimens shall be the full section of the bar rolled.

19. Report

19.1 The following information shall be reported on a per heat or per lot basis as is appropriate.

19.1.1 Stainless steel type and name,

19.1.2 Chemical composition and product check (if appropriate),

19.1.3 Heat treat condition,

19.1.4 Bar size,

19.1.5 Tensile properties,

19.1.6 Bend test (if required),

19.1.7 Hardness (if appropriate),

19.1.8 Corrosion test (if appropriate), and

19.1.9 Magnetic permeability (if appropriate).

19.2 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 6—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.

20. Inspection

20.1 The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector access to all reasonable facilities to satisfy him/her that the material is being furnished in accordance with this specification. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted so as not to interfere unnecessarily with the operation of the works.

20.2 *For Government Procurement Only*—Except as otherwise specified in the contract, the contractor is responsible for the performance of all inspection and test requirements specified herein. The contractor shall be permitted to use ones own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser at the time of purchase. The purchaser shall have the right to perform any of the inspections and tests at the same frequency as set forth in this specification where such inspections are deemed necessary to assure that the material conforms to the prescribed requirements.

21. Rejection

21.1 Unless otherwise specified, any rejection based on tests made in accordance with 6.3 shall be reported to the manufacturer within five days from the receipt of samples by the purchaser.

21.2 Material that shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected and the manufacturer shall be notified.

22. Rehearing

22.1 Samples tested in accordance with 6.3 that represent rejected material shall be preserved for two weeks from the date rejection is reported to the manufacturer. In case of dissatisfaction with the results of the tests, the manufacturer shall have the right to make claim for a rehearing within that time.

23. Marking

23.1 When loaded for mill shipment, bars shall be properly separated and tagged with the manufacturer's heat or test identification number.

23.2 Each manufacturer shall identify the symbols of his/her marking system.

23.3 All bars produced to this specification shall be identified by distinguishing marks legibly rolled onto the surface of one side of the bar to denote in the following order:

23.3.1 *Point of Origin*—Letter or symbol established as the manufacturer's mill designation.

23.3.2 *Size Designation*—Arabic number corresponding to bar designation number of Table 1.

23.4 In addition to the bar marks, the following information shall be tagged on each bundle:

23.4.1 Stainless-steel alloy, and

23.4.2 Heat treat condition, and

23.4.3 Grade (corresponding to minimum yield strength level), and

23.4.4 Meets supplementary requirements S1 if appropriate

23.5 For plain rounds, no rolled on symbols are required and all of the above information shall be tagged.

24. Packaging and Package Marking

24.1 Packing, marking, and loading for shipment shall be in accordance with Practices A 700.

24.2 When specified in the contract or order, and for direct procurement by or direct shipment to the U.S. government, marking for shipment, in addition to requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for military agencies and with Fed. Std. No. 123 for civil agencies.

25. Keywords

25.1 concrete reinforcement; corrosion resistance; deformations (protrusions); magnetic properties; stainless steel bars

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified in the purchase order or contract.

S1. Magnetic Permeability Testing

S1.1 (See 13.1.) When material of a low permeability is desired, the purchaser shall specify that the material be tested to Test Methods A 342. The specific limits of magnetic permeability shall be a matter of agreement between the manufacturer and the purchaser.

ANNEXES

(Mandatory Information)

A1. EVALUATION OF CORROSION RESISTANCE

A1.1 The corrosion resistance of the reinforcing steel, including the method of removing the mill scale, shall be evaluated based on either A1.2 or A1.3.

A1.2 Using a macrocell test of bare bars in a simulated concrete pore 15 % NaCl solution over a 15-week period, as specified in Annex A2, the average corrosion rate for a minimum of five specimens shall at no time during the test exceed 0.25 µm/year, with no single specimen exceeding a corrosion rate of 0.50 µm/year.

A1.3 Using a cracked beam test over a 75-week period, as specified in Annex A.3, the average corrosion rate for a minimum of five specimens shall at no time during the test exceed 0.20 µm/year, with no single specimen exceeding a corrosion rate of 0.50 µm/year.

A2. RAPID MACROCELL TEST

A2.1 Scope

A2.1.1 This test method describes procedures to measure the corrosion rate and corrosion potential of concrete reinforcing steel using the rapid macrocell test.

A2.2 Test Equipment and Materials

A2.2.1 *Plastic Containers*—Two 4.5-quart [4.5-L] plastic containers per test, approximately 7 in. [180 mm] in diameter by 7.5 in. [190 mm] in depth for each test setup.

A2.2.2 *Voltmeter*—High impedance voltmeter (at least one Mohm) capable of measuring 0.001 mV.

A2.2.3 *Reference Electrode*—A saturated calomel electrode, as defined in Practices G 15.

A2.2.4 *Resistor*—10-ohm (± 0.3 ohms) electrical resistor.

A2.2.5 *Terminal Box*—Terminal boxes are used to make the electrical connections between the test specimens. Each terminal box consists of a project box with a minimum of 6 pairs of binding posts (identified here as red and black). A 10-ohm resistor connects each pair of binding posts in the terminal boxes.

A2.2.6 *Wire*—16-gauge [1.5 mm2] insulated copper wire is used to make the electrical connections to the bars.

A2.2.7 *Epoxy Coating*—A two-part epoxy coating (such as used to as patching material for epoxy-coated bars) shall be used to cover the electrical connections. It shall be applied in accordance with manufacturer's recommendations.

A2.2.8 *Concrete Pore Solution*—Simulated concrete pore solution is prepared as follows: One litre of pore solution contains 974.8 g of distilled water, 18.81 g of potassium hydroxide (KOH), 17.87 g of sodium hydroxide (NaOH).

A2.2.9 *Sodium Chloride Solution*—The sodium chloride solution is prepared by adding 172.1 g of NaCl to one liter of simulated concrete pore solution to obtain a 15% (6.04 molal ion) concentration solution.

A2.2.10 *Salt Bridges*—Salt bridges provide an ionic path between the solutions surrounding the cathode and the anode. The salt bridges shall be prepared as follows: A salt bridge consists of a flexible latex tube with an inner diameter of 3/8 in. (9.5 mm), filled with a gel. The gel is made using 4.5 g of agar, 30 g of potassium chloride (KCl), and 100 g of distilled water,