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Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength[1]

This standard is issued under the fixed designation A 490; 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 Department of Defense.

1. Scope *

1.1 This specification covers the chemical and mechanical requirements of heat-treated steel bolts, ½ to 1 ½ in., incl, in diameter. These bolts are intended for use in structural joints that are made under the Specification for Structural Joints Using ASTM A 325 or A 490 Bolts[2] issued by the Research Council on Structural Connections of the Engineering Foundation. The various types of bolts covered by this specification are:

1.1.1 *Type 1*—Bolts made of alloy steel, supplied in sizes ½ to 1 ½ in., inclusive, in diameter.

1.1.2 *Type 2*—Bolts made from what is generally described as low-carbon martensite steel, supplied in sizes ½ to 1 in., inclusive, in diameter.

1.1.3 *Type 3*—Bolts ½ to 1 ½ in., inclusive, in diameter having atmospheric corrosion resistance and weathering characteristics comparable to that of the steels covered in Specifications A 588/A 588M, A 242/A 242M, and A 709/A 709M. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition. See 6.3. When properly exposed to the atmosphere, these steels can be used bare (uncoated) for many applications.

1.2 The purchaser should specify either Type 1, 2, or 3 bolts. When the bolt type is not specified, Type 1, 2, or 3 may be furnished at the option of the manufacturer.

1.3 When atmospheric corrosion resistance and weathering characteristics are required, Type 3 bolts should be specified by the purchaser.

1.4 Unless otherwise specified, all nuts used on these bolts shall conform to the requirements of Specification A 194/A 194M or A 563, shall be heavy hex, and shall be of the class and surface finish for each type of bolt as follows:

Bolt Type and Finish	Nut Class and Finish
1 and 2, plain (noncoated)	A 563 – DH, DH3, plain A 194 – 2H, plain
3, plain	A 563 – DH3, plain

1.5 Unless otherwise specified, all washers used on these bolts shall conform to the requirements of Specification F 436 and shall be of a surface finish for each type of bolt as follows:

Bolt Type and Finish	Washer Finish
1 and 2, plain (uncoated)	plain (uncoated)
3, plain	weathering steel, plain

1.6 This specification provides that heavy hex structural bolts shall be furnished unless other dimensional requirements are stipulated in the purchase inquiry and order.

NOTE 1—For quenched and tempered alloy steel bolts, studs, and other externally threaded fasteners with diameters greater than 1 ½ in., but with similar mechanical properties, refer to Grade BD of Specification A 354.

NOTE 2—A complete metric companion to Specification A 490 has been developed—Specification A 490M; therefore no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service[3]

A 242/A242M Specification for High-Strength Low-Alloy Structural Steel[4]

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength[5]

A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners[5]

A 563 Specification for Carbon and Alloy Steel Nuts[5]

A 588/A588M Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4 in. [100 mm] Thick[4]

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, and Washers.

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[2] Published by the American Institute of Steel Construction, Wrigley Building, 400 N. Michigan Ave., Chicago, IL 60611.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

[4] *Annual Book of ASTM Standards*, Vol 01.04.

[5] *Annual Book of ASTM Standards*, Vol 01.08.

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

A 709/A709M Specification for Structural Steel for Bridges[4]
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[6]
D 3951 Practice for Commercial Packaging[7]
E 3 Methods of Preparation of Metallographic Specimens[8]
E 138 Method for Wet Magnetic Particle Inspection[9]
E 709 Guide for Magnetic Particle Examination[10]
F 436 Specification for Hardened Steel Washers[5]
F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets[5]
F 788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series[5]
G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels[11]

2.2 *ANSI/ASME Standards:*
B1.1 Unified Screw Threads[12]
B18.2.1 Square and Hex Bolts and Screws[12]
B18.24.1 Part Identifying Number (PIN) Code System[13]

2.3 *Military Standard:*
MIL-STD-105 Sampling Procedure and Tables for Inspection by Attributes[14]

3. Terminology

3.1 *Definitions*—Surface discontinuities covered in this specification are defined as follows:

3.1.1 *acceptable quality level (AQL)*—as defined in MIL-STD-105, the maximum percent defective that, for purposes of sampling inspection, can be considered satisfactory as the process average.

3.1.2 *burst*—a break located at the periphery of the bolt head.

3.1.3 *crack*—a clean crystalline break passing through the grain boundary without inclusion of foreign elements.

3.1.4 *process average*—as defined in MIL-STD-105, the average percent defective of product at the time of original inspection. Original inspection is that first inspection of a particular quantity of product which is being reinspected after rejection and reconditioning.

3.1.5 *seam or lap*— a noncrystalline break through the metal which is inherent in the raw material.

4. Ordering Information

4.1 Orders for products under this specification shall include the following:

4.1.1 Quantity (number of pieces of bolts and accessories),

4.1.2 Name of products, including accessories such as nuts and washers when desired,

4.1.3 Dimensions, including nominal bolt diameter and length. For bolts of dimensional requirements other than heavy hex structural bolts (see 1.6) it is normally necessary to specify grip length,

4.1.4 Type of bolt (that is, Type 1, 2, or 3). Note that Type 1, 2, or 3 bolts may be supplied by the manufacturer when bolt type is not specified,

4.1.5 ASTM designation and year of issue,

4.1.6 Whether proof load tests are required,

4.1.7 Specify if Test Reports are required, and

4.1.8 Any special requirements.

4.1.9 For establishment of a part identifying system, see ASME B18.24.1.

NOTE 3—Two examples of ordering descriptions follow: (*1*) 1000 pieces, heavy hex structural bolts, each with two hardened washers, ASTM F 436, and one heavy hex nut, ASTM A 563 Grade DH, 1 by 4, ASTM A 490–XX. (*2*) 1000 pieces, heavy hex structural bolts, no nuts or washers, ⅞ by 2¼ Type 1, ASTM A 490–XX.

5. Materials and Manufacture

5.1 *Process*—Steel shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

5.2 *Heat Treatment*—Type 1 bolts shall be heat treated by quenching in oil from above the transformation temperature. Type 2 and Type 3 bolts shall be quenched in a suitable liquid from above the transformation temperature. Type 1 and Type 3 bolts shall be tempered by reheating to a temperature of not less than 800°F. Type 2 bolts shall be tempered by reheating to a temperature of not less than 650°F. If heat treatment is performed by a subcontractor, the heat-treated material shall be returned to the manufacturer for testing.

5.3 Threads of bolts may be cut or rolled.

5.4 *Protective Coatings*—The bolts shall not be hot dip, mechanically, or electroplated with zinc or other metallic coatings as such bolts are subject to hydrogen embrittlement with subsequent stress corrosion cracking and delayed brittle failure in service. See Appendix X1 for additional information on hot dip zinc coatings.

6. Chemical Composition

6.1 Type 1 bolts shall be made from alloy steel conforming to the chemical composition requirements given in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel.

NOTE 4—Steel is considered to be alloy, by the American Iron and Steel Institute, when the maximum of the range given for the content of alloying

TABLE 1 Chemical Requirements for Type 1 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1⅜ in.	0.30–0.48	0.28–0.50
For size 1½ in.	0.35–0.53	0.33–0.55
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Alloying Elements ←	→ See 6.1	

[6] *Annual Book of ASTM Standards*, Vol 01.03.
[7] *Annual Book of ASTM Standards*, Vol 15.09.
[8] *Annual Book of ASTM Standards*, Vol 03.01.
[9] Discontinued; see 1980 *Annual Book of ASTM Standards*, Part 11.
[10] *Annual Book of ASTM Standards*, Vol 03.03.
[11] *Annual Book of ASTM Standards*, Vol 03.02.
[12] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.
[13] Available from American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.
[14] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

elements exceeds one or more of the following limits: manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

6.2 Type 2 bolts shall be made from steel conforming to the chemical composition requirements given in Table 2.

6.3 Type 3 bolts shall be made from steel conforming to the chemical composition requirements given in Table 3. See Guide G 101 for methods of estimating the atmospheric corrosion resistance of low alloy steel.

6.4 Product analyses may be made by the purchaser from finished material representing each lot of bolts. The chemical composition thus determined shall conform to the requirements given in Table 1, Table 2, or Table 3, as applicable.

6.5 Application of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for bolts.

6.6 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

7. Mechanical Properties

7.1 *Product Hardness*:

7.1.1 The bolts shall conform to the hardness specified in Table 4.

7.2 *Tensile Properties*:

7.2.1 Bolts 1 ¼ in. in diameter or less, other than those excepted in 7.1, shall be wedge tested full size and conform to the minimum and maximum tensile strength requirements as specified in Table 5.

7.2.2 Bolts larger than 1¼ in. in diameter, other than those excepted in 7.1, shall preferably be wedge tested full size and when so tested, shall conform to the minimum and maximum tensile strength requirements as specified in Table 5. When equipment of sufficient capacity for full-size testing is not available, or when the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements of Table 6. In the event that bolts are tested by both full-size and by the machined test specimen methods, the full-size test shall govern if a controversy between the two methods exists.

7.2.3 The proof load test is not a mandatory production test. When specified on the inquiry and order, the bolts shall be tested to either the proof load or alternative proof load requirements specified in Table 5 in addition to the tensile strength requirements. In case of controversy the bolts shall be capable of conforming to the proof load requirements in addition to all other requirements.

TABLE 2 Chemical Requirements for Type 2 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon	0.15–0.34	0.13–0.37
Manganese, min	0.70	0.67
Phosphorus, max	0.040	0.048
Sulfur, max	0.050	0.058
Boron, min	0.0005	0.0005

TABLE 3 Chemical Requirements for Type 3 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes 0.75 in. and smaller	0.20–0.53	0.19–0.55
Sizes larger than 0.75 in.	0.30–0.53	0.28–0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.040	0.045
Sulfur, max	0.050	0.055
Copper, max	0.60	0.63
Chromium, min	0.45	0.42
Nickel, min or	0.20	0.17
Molybdenum, min	0.15	0.14

TABLE 4 Hardness Requirements for Bolts ½ to 1 ½ in. Nominal Size

Length, in.	Brinell		Rockwell C	
	min	max	min	max
Less than 3 × dia.	311	352	33	38
3 × dia. and longer	—	352	—	38

7.3 For bolts on which hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event that there is controversy over low readings of hardness tests.

8. Carburization

8.1 *Definition*—This test is intended to evaluate freedom from carburization as determined by the difference in hardness at the surface and subsurface.

8.2 *Requirement*—The bolts shall be free from carburization. The hardness measured at a maximum of 0.003 in. from the surface shall not be more than 3 points Rockwell C (26 points Knoop) (27 points Vickers DPH) higher than the hardness measured 0.125 in. from the surface. See Fig. 1.

8.3 *Procedure*:

8.3.1 Section the bolt longitudinally through the axis in the threaded area. Mount and polish metallographically in accordance with Methods E 3.

8.3.2 Conduct a microhardness test using either a Knoop or Vickers DPH hardness testing penetrator.

8.3.3 Locate a point at the pitch diameter 0.003 in. in from the flank of the thread on a line perpendicular to the flank and take a hardness reading. For the next reading, locate a point 0.125 in. from the major diameter (crest of thread) perpendicular to the axis of the bolt and take a second reading. See Fig. 1.

8.3.4 Both hardness readings shall be taken on the same axial longitudinal section through the threaded length of the bolt, shall be taken at the same time, and the same hardness scale shall be used.

9. Dimensions

9.1 Unless otherwise specified, bolts shall conform to the dimensions for heavy hex structural bolts specified in ANSI B18.2.1.

9.2 Threads shall be the Unified Coarse Thread Series as specified in ANSI B1.1, and shall have Class 2A tolerances. When specified, 8 pitch thread series shall be used on bolts over 1 in. in diameter.

TABLE 5 Tensile Requirements for Full-Size Bolts

Bolt Size, Threads per Inch, and Series Designation	Stress Area,[A] in.^{2}	Tensile Load,[B] lbf		Proof Load,[B] lbf	Alternative Proof Load,[B] min, lbf
		min	max	Length Measurement Method	Yield Strength Method
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
½-13 UNC	0.142	21 300	24 150	17 050	18 500
⅝-11 UNC	0.226	33 900	38 400	27 100	29 400
¾-10 UNC	0.334	50 100	56 800	40 100	43 400
⅞-9 UNC	0.462	69 300	78 550	55 450	60 100
1-8 UNC	0.606	90 900	103 000	72 700	78 800
1⅛-7 UNC	0.763	114 450	129 700	91 550	99 200
1⅛-8 UN	0.790	118 500	134 300	94 800	102 700
1¼-7 UNC	0.969	145 350	164 750	116 300	126 000
1¼-8 UN	1.000	150 000	170 000	120 000	130 000
1⅜-6 UNC	1.155	173 250	196 350	138 600	150 200
1⅜-8 UN	1.233	185 000	209 600	148 000	160 300
1½-6 UNC	1.405	210 750	238 850	168 600	182 600
1½-8 UN	1.492	223 800	253 650	175 050	194 000

[A] The stress area is calculated as follows:

$$A_s = 0.7854\,[D - (0.9743/n)]^2$$

where:
A^s = stress area, in.^{2}
D = nominal bolt size, and
n = threads per inch.

[B] Loads tabulated and loads to be used for tests of full-size bolts larger than 1 ½ in. in diameter are based on the following:

Bolt Size	Column 3	Column 4	Column 5	Column 6
½to 1½ in., incl	150 000 psi	170 000 psi	120 000 psi	130 000 psi

TABLE 6 Tensile Requirements for Specimens Machined from Bolts

Bolt Size, in.	Tensile Strength, psi		Yield Strength (0.2 % offset), min, psi	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %
	min	max			
½ to 1½ in., incl	150 000	170 000	130 000	14	40

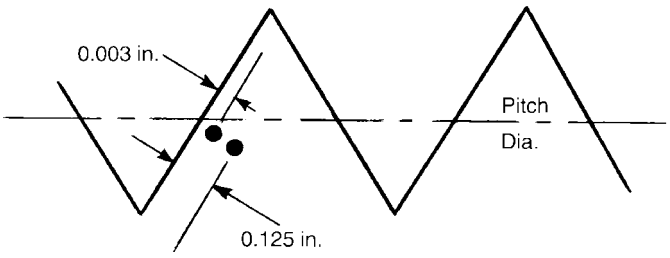

FIG. 1 Carburization Hardness Test Location (Not to Scale)

10. Workmanship

10.1 Surface discontinuity limits shall be in accordance with Specification F 788/F 788M.

11. Quality Assurance of Mechanical Properties

11.1 The manufacturer shall make sample inspections of every lot of bolts to ensure that properties of bolts are in conformance with the requirements of this specification. All bolts shall be inspected tested prior to shipment in accordance with one of the two quality assurance procedures described in 11.3 and 11.4, respectively. The manufacturer shall have the option of which procedure will be followed when furnishing bolts to any single purchase order.

11.2 The purpose of a lot inspection testing program is to ensure that each lot conforms to the requirements of this specification. For such a plan to be fully effective, it is essential that following delivery the purchaser continue to maintain the identification and integrity of each lot until the product is installed in its service application.

11.3 *Production Lot Method*:

11.3.1 All bolts shall be processed in accordance with a lot-identification-control quality assurance plan. The manufacturer shall identify and maintain the integrity of each production lot of bolts from raw-material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot-identification number, each lot shall be tested, and the inspection test reports for each lot shall be retained.

11.3.2 A production lot, for purposes of assigning an identification number and from which test samples shall be selected, shall consist of all bolts processed essentially together through all operations to the shipping container that are of the same nominal size, the same nominal length, and produced from the same mill heat of steel.

11.3.3 The manufacturer shall test each lot of bolts for (1)

product hardness (7.1), in accordance with Test Methods F 606; (2) full-size wedge-test tensile strength or machined specimen tensile properties depending on size and length as required by 7.2; and (3) carburization (Section 8). Proof load tests shall be conducted only when specified on the purchase order.

11.3.4 From each production lot, the minimum number of tests of each required property shall be in accordance with Table 7.

11.3.5 If any test specimen shows defective machining, it may be discarded and another specimen substituted.

11.3.6 Bolts shall be packed in shipping containers as soon as practicable following final processing. Shipping containers shall be marked with the lot identification number.

11.3.7 A copy of the inspection test report for each production lot from which bolts are supplied to fill the requirements of a shipment shall be furnished to the purchaser when specified in the order. Individual heats of steel need not be identified on the test report.

11.4 *Shipping Lot Method*:

11.4.1 In-process inspection during all manufacturing operations and treatments and storage of manufactured bolts shall be in accordance with the practices of the individual manufacturer.

11.4.2 Before packing bolts for shipment, the manufacturer shall make tests of sample bolts taken at random from each shipping lot. A shipping lot, for purposes of selecting test samples, is defined as that quantity of bolts of the same nominal size and same nominal length necessary to fill the requirements of a single purchase order.

11.4.3 The manufacturer shall test each lot of bolts for (1) product hardness (7.1), in accordance with Test Methods F 606; (2) full size wedge test tensile strength or machined specimen tensile properties depending on size and length as required by 7.2; and (3) carburization (Section 8). Proof load tests shall be conducted only when specified on the purchase order.

11.4.4 From each shipping lot, the minimum number of tests of each required property shall be in accordance with Table 8.

11.4.5 If any test specimen shows defective machining, it may be discarded and another specimen substituted.

11.4.6 A copy of the inspection test report for each shipping lot shall be furnished to the purchaser when specified in the order. Individual heats of steel are not identified in the finished product.

TABLE 7 Production Lot Sample Size With Acceptance and Rejection Numbers for Inspection of Mechanical and Dimensional Requirements

Lot Size	Sample Size	Acceptance Number	Rejection Number
25 and less	2	0	1
26 to 150	3	0	1
151 to 1 200	5	0	1
1 201 to 35 000	8	0	1
35 001 to 150 000	13	0	1
150 001 and over	20	0	1

TABLE 8 Shipping Lot Sample Size With Acceptance and Rejection Numbers for Inspection of Mechanical and Dimensional Requirements

Lot Size	Sample Size	Acceptance Number	Rejection Number
25 and less	2	0	1
26 to 50	3	0	1
151 to 1 200	5	0	1
1 201 to 10 000	8	0	1
10 001 to 35 000	13	0	1
35 001 to 150 000	20	0	1
150 001 and over	32	0	1

12. Test Methods

12.1 Tests shall be conducted in accordance with Test Methods F 606.

12.2 Proof load testing of bolts tested in full size shall preferably be conducted in accordance with Method 1, Length Measurement, described in the section, Test Methods for Externally Threaded Fasteners, of Test Methods F 606.

12.3 Bolts tested in full size shall be tested in accordance with the Wedge Test method described in Wedge Tension Testing of Full-Size Product paragraph, of Test Methods F 606. Fracture shall be in the body or threads of the bolt, without any fracture at the junction of the head and body.

12.4 Machined specimens shall be tested in accordance with the method described in the paragraphs on Tension Testing of Machine Test Specimens, of Test Methods F 606.

12.5 The speed of testing as determined with a free-running cross head shall be a maximum of 0.125 in./min for the bolt proof load determination, and a maximum of 1 in./min for the bolt tensile strength determination.

13. Magnetic Particle and Visual Inspection for Surface Discontinuities

13.1 Bolts shall be examined by magnetic particle inspection for longitudinal discontinuities and transverse cracks, and shall conform to an AQL of 0.25 when inspected in accordance with the sampling plan described in 13.4. Eddy-current inspection may be substituted, at the option of the manufacturer, for the 100 % magnetic particle inspection specified in 13.4.1 and 13.4.2, provided that the bolts, after eddy current inspection, are subsequently randomly sampled according to Table 9 and subjected to the magnetic particle inspection and acceptance requirements as described above. In the case of dispute, the magnetic particle test shall govern.

TABLE 9 Sample Sizes with Acceptance and Rejection Numbers for Inspection of Rejectable Longitudinal Discontinuities and Transverse Cracks

Lot Size	Sample Size[A,B]	Acceptance Number[A]	Rejection Number
2 to 50	all	0	1
51 to 500	50	0	1
501 to 1200	80	0	1
1201 to 3200	125	0	1
3201 to 10 000	200	0	1

[A] Sample sizes, acceptance numbers, and rejection numbers are extracted from "Single Sampling Plan for Normal Inspection" Table IIA, MIL-STD-105.

[B] Inspect all bolts in the lot if lot size is less than sample size.

13.2 Bolts shall be examined visually for bursts and shall meet an AQL of 2.5 when inspected in accordance with the sampling plan described in 13.5.

13.3 A lot, for purposes of selecting a sample for magnetic particle or visual inspection, shall consist of all bolts of one type, having the same nominal diameter and length offered for inspection at one time. No lot shall contain more than 10 000 pieces.

13.4 *Longitudinal Discontinuities and Transverse Cracks*:

13.4.1 From each lot of bolts a representative sample shall be picked at random and magnetic particle inspected for rejectable longitudinal discontinuities and transverse cracks (as described in 13.4.2) in accordance with Guide E 709. (See Note 5.) The sample size shall be as specified for an AQL of 0.25 in Table 9. If any defectives are found during inspection by the manufacturer all bolts in the lot shall be magnetic particle inspected and all defectives shall be removed and destroyed. If any defectives are found during inspection by the purchaser the lot shall be subject to rejection.

NOTE 5—Magnetic particle inspection may be conducted in accordance with Method E 138. For referee purposes Guide E 709 shall be used.

13.4.2 Any bolt with a longitudinal discontinuity (located parallel to the axis of the bolt in the threads, body, fillet, or underside of head), with a depth normal to the surface greater than 0.03 *D*, where *D* is the normal bolt size in inches, shall be considered defective. In addition, any bolt with a transverse crack (located perpendicular to the axis of the bolt in the threads, body, fillet, or underside of head), shall be considered defective.

NOTE 6—Magnetic particle indications of themselves shall not be cause for rejection. If in the opinion of the inspector the indications may be cause for rejection, a representative sample shall be taken from those bolts showing indications and shall be further examined by microscopical examination to determine whether the indicated discontinuities are in accordance with the specific limits.

13.5 *Bursts*:

13.5.1 From each lot of bolts a representative sample shall be picked at random and visually inspected for bursts. The sample size shall be as specified for an AQL of 2.5 in Table 10. If the number of defectives found during inspection by the manufacturer is greater than the acceptance number given in Table 10 for the sample size, all bolts in the lot shall be visually inspected and all defectives shall be removed and destroyed. If the number of defectives found during inspection by the purchaser is greater than the acceptance number given in Table 10 for the sample size, the lot shall be subject to rejection.

TABLE 10 Sample Sizes with Acceptance and Rejection Numbers for Inspection of Bursts 2.5 AQL

Lot Size	Sample Size[A,B]	Acceptance Number[A]	Rejection Number
2 to 8	2	0	1
9 to 15	3	0	1
16 to 25	5	0	1
26 to 150	20	1	2
151 to 280	32	2	3
281 to 500	50	3	4
501 to 1200	80	5	6
1201 to 3200	125	7	8
3201 to 10 000	200	10	11

[A] Sample sizes, acceptance numbers, and rejection numbers are extracted from "Single Sampling Plan for Normal Inspection" Table IIA, MIL-STD-105.

[B] Inspect all bolts in the lot if the lot size is less than the sample size.

13.5.2 Any bolt with a burst having a width greater than 0.010 in. plus 0.025*D*, where *D* is the nominal bolt size in inches, shall be considered defective.

14. Inspection

14.1 If the inspection described in 14.2 is required by the purchaser, it shall be specified in the inquiry and contract or order.

14.2 The inspector representing the purchaser shall have free entry to all parts of manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the works.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

16. Certification

16.1 When specified on the order the manufacturer shall furnish the test reports described in 11.3.7 or 11.4.6, depending on whether the bolts are furnished by the production lot or shipping lot method.

17. Responsibility

17.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser and certifies that the fastener was manufactured, sampled, tested and inspected in accordance with this specification and meets all of its requirements.

18. Product Marking

18.1 Bolt heads shall be marked A 490, and shall also be marked to identify the manufacturer or private label distributor, as appropriate. Markings may be either raised or depressed, at the option of the manufacturer.

18.2 In addition to the markings required in 18.1, Type 2 bolts shall be marked with six radial lines 30° apart.

18.3 In addition to the markings required in 18.1, Type 3 bolts shall have the A 490 underlined, and the manufacturer may add other distinguishing marks indicating that the bolt is atmospheric corrosion resistant and of a weathering type.

18.4 Type and manufacturer's or private label distributor's identification shall be separate and distinct. The two identifications shall preferably be in different locations and, when on the same level, shall be separated by at least two spaces.

19. Packaging and Package Marking

19.1 *Packaging:*

19.1.1 Unless otherwise specified, packaging shall be in accordance with Practice D 3951.

19.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

19.2 *Package Marking*:

19.2.1 Each shipping unit shall include or be plainly marked with the following information:

19.2.1.1 ASTM designation and type,

19.2.1.2 Size,

19.2.1.3 Name and brand or trademark of the manufacturer,

19.2.1.4 Number of pieces,

19.2.1.5 Lot number,

19.2.1.6 Purchase order number, and

19.2.1.7 Country of origin.

20. Keywords

20.1 alloy steel; bolts; steel; structural; weathering steel

APPENDIX

(Nonmandatory Information)

X1. EFFECT OF HOT DIP ZINC COATING ON THE STREGTH OF STEEL

X1.1 Steels in the 200 ksi and higher tensile strength ranges are subject to embrittlement if hydrogen is permitted to remain in the steel and the steel is subjected to high tensile stress. The maximum tensile strength for A 490 bolts was set at 170 ksi to provide a 15% margin below 200 ksi. However, because manufacturers must target their production slightly higher than the required minimum, A 490 bolts close to the critical range of tensile strength must be anticipated. For black bolts this is not a cause for concern. For hot dip zinc coated bolts, a hazard of delayed brittle fracture in service exists because the real possibility of inclusions of hydrogen into the steel during the pickling operation of the zinc coating process and the subsequent "sealing in'' of the hydrogen by the zinc coating. Hot dip zinc coating of A 490 bolts is therefore not recommended.[15]

[15] For more detail see the H. E. Townsend Report, "Effects of Zinc Coatings on Stress Corrosion Cracking and Hydrogen Embrittlement of Low Alloy Steel'', published in Metallurgical Transactions, Vol 6, April 1975.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this standard that have been incorporated since the –97 issue. For the convenience of the user, Committee F16 has highlighted those changes that impact the use of this standard. This section may also include descriptions of the changes or reasons for the changes, or both.

(1) Added 4.1.9, providing for optional use of ASME B18.24.1, Part Identifying Number (PIN) Code System.