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

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Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength[1]

This standard is issued under the fixed designation F3125/F3125M; 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 chemical, physical and mechanical requirements for quenched and tempered bolts manufactured from steel and alloy steel, in inch and metric dimensions, in two strength grades, two types and two styles.

1.1.1 This specification is a consolidation and replacement of six ASTM standards, including; A325, A325M, A490, A490M, F1852 and F2280.

1.1.2 This consolidated standard is to ensure alignment between standards with the same intended end use and to simplify the use and maintenance of structural bolt specifications.

1.2 *Intended Use:*

1.2.1 Bolts manufactured under this specification are intended for use in structural connections covered in the Specification for Structural Joints Using High-Strength Bolts, as approved by the Research Council on Structural Connections.

1.2.2 Bolts in this specification are furnished in sizes from ½ to 1-½ in. inclusive and from M12 to M36 inclusive.

1.3 *Classification,* Table 1*:*

1.3.1 Bolts are designated by grade, which indicates inch or metric strength and style.

1.3.2 Bolts are designated by type denoting raw material chemical composition.

1.3.3 Bolts are designated by style denoting Heavy Hex bolts or "Twist-Off" Style assemblies.

1.4 Terms used in this specification are defined in F1789.

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

1.6 Table footnotes are requirements. Notes are advisory.

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

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A449 Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

A563/A563M Specification for Carbon and Alloy Steel Nuts (Inch and Metric)

A751 Test Methods and Practices for Chemical Analysis of Steel Products

B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

E709 Guide for Magnetic Particle Testing

E1444/E1444M Practice for Magnetic Particle Testing for Aerospace

[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, Studs and Nuts.

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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**

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TABLE 1 Classification

Grade	Min. Strength	Type[A]		Style
A325	120 ksi	1	3	Heavy Hex Head
A490	150 ksi	1	3	Heavy Hex Head
F1852	120 ksi	1	3	Twist-Off
F2280	150 ksi	1	3	Twist-Off
A325M	830 MPa	1	3	Heavy Hex Head
A490M	1040 MPa	1	3	Heavy Hex Head

[A] Type 1 - 120 ksi (830 MPa) - carbon steel, carbon boron steel, alloy steel or alloy steel with boron addition
Type 3 - 120 ksi (830 MPa) or 150 ksi (1040 MPa) - weathering steel
Type 1 - 150 ksi (1040 MPa) - alloy steel or alloy steel with boron addition

F436/F436M Specification for Hardened Steel Washers Inch and Metric Dimensions
F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F788 Specification for Surface Discontinuities of Bolts, Screws, Studs, and Rivets, Inch and Metric Series
F1136/F1136M Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
F1789 Terminology for F16 Mechanical Fasteners
F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners
F2328 Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts
F2328M Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts (Metric)
F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
F2660 Test Method for Qualifying Coatings for Use on F3125 Grade A490 Structural Bolts Relative to Environmental Hydrogen Embrittlement
F2833 Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
F3019/F3019M Specification for Chromium Free Zinc-Flake Composite, with or without Integral Lubricant, Corrosion Protective Coatings for Fasteners
F3393 Specification for Zinc-Flake Coating Systems for Fasteners
G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 *ASME Standards:*[3]
B1.1 Unified Screw Threads
B1.13M Metric Screw Threads
B18.18 Quality Assurance for Fasteners
B18.2.6 Fasteners for Use in Structural Applications
B18.2.6M Metric Fasteners for Use in Structural Applications

2.3 *IFI Standard:*[4]
IFI 144 Test Evaluation Procedures for Coating Qualification

2.4 *RCSC Standard:*[5]
Specification for Structural Joints Using High-Strength Bolts

3. Ordering Information

3.1 Orders for bolts under this specification shall include:

3.1.1 *ASTM designation.*

3.1.2 *Quantity:* Number of bolts or assemblies, including washers, if required.

3.1.3 *Size:* Including nominal bolt diameter and bolt length, and thread pitch if other than standard.

3.1.4 *Grade:* A325, A490, F1852, F2280 or A325M, A490M.

3.1.5 *Type:* Type 1 or Type 3. When Type is not specified either Type 1 or Type 3 may be furnished at the supplier's option.

3.1.6 *Style:* Heavy Hex or Twist-Off Style.

3.1.7 *Coatings or finishes:* If other than plain finish, specify the coating process or finish required, see Annex A1.

3.2 *Test reports,* see Section 14.

3.3 Additional details of other assembly components such as nuts and washers, if required.

3.4 Rotational capacity testing of matched sets or assemblies in accordance with Annex A2, as required in 8.1.5 and when requested by the purchaser.

3.5 Heavy Hex bolts may be ordered individually, packaged with nuts, packaged with nuts and washers, or as assemblies.

3.6 Any special observation or inspection requirements shall be specified at the time of inquiry and at the time of order. See Section 13.2.

3.7 Any supplementary requirements.

3.8 Country of origin requirements, if any.

NOTE 1—A typical description follows: 1000 pieces ¾ in.× 3 in. ASTM F3125–19, Grade A325 Heavy Hex Bolt, Type 1, each with one ASTM F436/F436M Type 1 Hardened Washer, and one A563/A563M Grade DH Heavy Hex Nut.

NOTE 2—Bolts are sometimes detailed with names such as A325 HS, A325 SC, A325 X or A490 N. These names relate to connection design and bolt installation, but do not change the manufacturing requirements and are preferably not shown on bolt orders.

4. Dimensions

4.1 *Head and Body:*

4.1.1 Bolts shall conform to the dimensions specified in Table 2 for Heavy Hex or Twist-Off bolts.

4.1.2 The thread length shall not be changed except as provided in Supplementary Requirement S1 or S2. Other dimensions shall not be changed except in accordance with Supplementary Requirement S2.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Industrial Fasteners Institute (IFI), 6363 Oak Tree Blvd. Independence, OH 44131. http://www.indfast.org

[5] Research Council on Structural Connections (RCSC), http://www.boltcouncil.org

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TABLE 2 Dimensions, Threads, Marking, Matching Components

	Inch				Metric			
	120 ksi Min Tensile		150 ksi Min Tensile		830 MPa Min Tensile		1040 MPa Min Tensile	
	Type 1	Type 3	Type 1	Type 3	Type 1	Type 3	Type 1	Type 3
Style - Heavy Hex Bolts								
Dimensions, ASME[B]	B18.2.6	B18.2.6	B18.2.6	B18.2.6	B18.2.6M	B18.2.6M	B18.2.6M	B18.2.6M
Thread Fit, ASME[B]	B1.1 UNC 2A	B1.1 UNC 2A	B1.1 UNC 2A	B1.1 UNC 2A	B1.13M MC 6g	B1.13M MC 6g	B1.13M MC 6g	B1.13M MC 6g
Grade Marking[A,D]	A325	A325	A490	A490	A325M	A325M	A490M	A490M
Style - Twist-Off Bolts								
Dimensions, ASME[B]	B18.2.6	B18.2.6	B18.2.6	B18.2.6	[F]	[F]	[F]	[F]
Thread Fit, ASME[B]	B1.1 UNC 2A	B1.1 UNC 2A	B1.1 UNC 2A	B1.1 UNC 2A	[F]	[F]	[F]	[F]
Grade Marking[A,D]	A325TC	A325TC	A490TC	A490TC	[F]	[F]	[F]	[F]
Alt. Marking[A,C]	A325	A325	A490	A490	[F]	[F]	[F]	[F]
Recommended Nut and Washer								
Plain Nut	A563/A563M DH	A563/A563M DH3	A563/A563M DH	A563/A563M DH3	A563/A563M 10S	A563/A563M 10S3	A563/A563M 10S	A563/A563M 10S3
Suitable Alternative[E]	DH3, D, C, C3	C3			8S, 8S3, 10S3	8S3	10S3	
Coated Nut	A563/A563M DH	A563/A563M DH3	A563/A563M DH	A563/A563M DH3	A563/A563M 10S	A563/A563M 10S3	A563/A563M 10S	A563/A563M 10S3
Flat, Bevel or Thick Washer if used	F436/F436M - 1	F436/F436M - 3	F436/F436M - 1	F436/F436M - 3	F436/F436M - 1	F436/F436M - 3	F436/F436M - 1	F436/F436M - 3

[A] A325 and A325M bolts lengths up to 4D which are fully threaded but which are not required to be fully threaded by the relevant ASME standard shall be marked with a "T", see Supplementary Requirement S1. Bolts with any other non-standard dimensions, including non-standard thread length (except for bolts up to 4D threaded fully and marked with "T" per S1 requirement), shall be marked with an "S", see Supplementary Requirement S2.
[B] Manufactured to the latest revision at the time of manufacture, UNC for inch series and Metric Coarse (MC) for Metric Series.
[C] Previously used markings may be sold and used indefinitely, bolts must be manufactured to current marking requirements upon initial publication of this standard.
[D] Other distinguishing markings for type 3 are permitted at the manufacturers option.
[E] ASTM A194/A194M 2H Heavy Hex inch Nuts may be used in place of A563/A563M DH nuts on type 1 A325, A490, F1852 and F2280 bolts. 2H Heavy Hex metric Nuts may be used in place of A563/A563M 10S nuts on type 1 A325M and A490M bolts. When coated 2H nuts are used in place of DH or 10S nuts, the same requirements of A563/A563M and this specification, including Annex A1, shall apply. These requirements include, but are not limited to, thread dimensions and overtapping allowances, coating grade, lubrication requirements, and proof load testing.
[F] Metric dimensions and requirements for this style have not been established.

TABLE 3 Chemical Requirements[A]

Heat Analysis	120 ksi/830 MPa Minimum				150 ksi/1040 MPa Minimum	
	Grade A325, A325M, F1852				Grade A490, A490M, F2280	
	Type 1	Type 3			Type 1	Type 3
	Carbon or Alloy Steel with or without Boron	Composition A	Composition B	Based on Corrosion Index[B]	Alloy Steel with or without Boron	Based on Corrosion Index[B]
Carbon	0.30 - 0.52	0.33 - 0.40	0.38 -0.48	0.30 - 0.52 max	0.30 - 0.48[C]	0.30 - 0.53
Manganese	0.60 min	0.90 - 1.20	0.70 - 0.90	0.60 min	0.60 min	0.60 min
Phosphorus, max	0.035	0.035	0.035	0.035	0.035	0.035
Sulfur, max	0.040	0.040	0.040	0.040	0.040	0.040
Silicon	0.15 - 0.30	0.15 - .30	0.30 - 0.50	[D]	[D]	[D]
Boron	0.003 max	[D]	[D]	[D]	0.003 max	[D]
Copper	[D]	0.25 - 0.45	0.20 - 0.40	0.20 - 0.60	[D]	0.20 - 0.60
Nickel	[D]	0.25 - 0.45	0.50 - 0.80	0.20[E] min	[D]	0.20[E] min
Chromium	[D]	0.45 - 0.65	0.50 - 0.75	0.45 min	[D]	0.45 min
Vanadium	[D]	[D]	[D]	[D]	[D]	[D]
Molybdenum	[D]	[D]	0.06 max	0.10[E] min	[D]	0.10[E] min
Titanium	[D]	[D]	[D]	[D]	[D]	[D]

[A] Based on heat analysis.
[B] See 6.3.
[C] Carbon requirement is 0.35-0.53 for 1-½ in. and M36 diameter bolts.
[D] Not Specified.
[E] Material that satisfies the criteria for either Nickel or Molybdenum shall be considered as satisfying the requirements for both elements.

4.1.3 Bolts with thread lengths or dimensional requirements which differ from this specification may also be ordered under Specification A449 or A354. Users should note that A449 and A354 are not exact equivalents to the structural grades in this specification.

4.2 *Threads:*

4.2.1 Uncoated bolt threads shall be as specified in Table 2.

4.2.2 Coated bolts shall have threads meeting Table 2 requirements before coating.

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4.3 The gauging limit for coated bolts shall be verified during manufacture. In case of dispute, a calibrated thread ring gauge of the same size as the oversize limit in Annex A1 (Class X tolerance, gauge tolerance plus) shall be used to verify compliance. The gauge shall assemble with hand effort following application of light machine oil to prevent galling and damage to the gauge. These inspections, when performed to resolve controversy, shall be conducted at the frequency specified in the quality provisions of ASME B18.18.

NOTE 3—It is the intent of this specification that coated nuts and bolts assemble freely when ordered together. It is recognized that the batch nature of coating process and the cumulative effect of coating thickness may create intermittent assembly problems. Staying within the material limits is important for assembly strength. Users are encouraged to use the smallest nut overtap which permits consistent free assembly.

5. Product Marking

5.1 At a minimum, all bolts shall be marked as required in Table 2. Marking shall be on the bolt head and may be raised or depressed at the manufacturer's option. The marking shall be visible after coating.

5.2 Grade and Type marking, and the manufacturer's mark shall be in separate and distinct locations on the head. Other markings, if used, such as private label distributor's mark shall also be separate and distinct.

6. Chemical Composition

6.1 120ksi/830MPA Type 1 bolts shall be carbon steel, carbon boron steel, alloy steel or alloy steel with boron addition at the manufacturer's option, conforming to the chemical composition specified in Table 3.

6.2 150ksi/1040MPa bolts Type 1 shall be alloy steel or alloy steel with boron addition at the manufacturer's option, conforming to the chemical composition specified in Table 3.

6.3 Type 3 bolts shall be weathering steel and shall conform to the chemical compositions A or B specified in Table 3 or be produced from a material with chemical composition "Based on Corrosion Index" that has a corrosion index of 6 or greater, as calculated from the heat analysis, and as described in G101. Calculation of the corrosion index shall be done using the predictive method based on the data of Larabee and Coburn or the predictive method based on the data of Townsend. (see Guide G101 for methods of estimating the atmospheric corrosion resistance of low alloy steels).

6.4 If performed, product analysis made on finished bolts representing each lot shall be within 10% of the value required of the heat analysis. For example; heat analysis C 0.30–0.52 = product analysis C 0.27– 0.57.

6.5 Heats to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

6.6 Chemical analysis shall be performed in accordance with A751.

7. Materials and Manufacture

7.1 *Production Method:*

7.1.1 Bolts shall be cold formed, warm formed, hot formed, hot forged, machined, or any combination thereof.

7.2 *Heat Treatment:*

7.2.1 All bolts shall be quenched in oil from the austenitizing temperature.

7.2.2 All bolts shall be tempered by reheating to not less than 800°F/427°C.

7.3 Threads may be rolled or cut.

7.4 *Coatings and Other Finishes:*

7.4.1 Permitted coatings, including supplementary lubrication and nut oversize requirements, are provided in Annex A1.

7.4.2 When coated fasteners are required, the purchaser shall specify the process and any additional special requirements.

7.4.3 Threaded components (bolts and nuts) shall be coated by the same process, limited to one process per item with no mixed processes in a lot.

7.5 *Secondary Processing:*

7.5.1 Lot control and full traceability shall be maintained throughout all outside or secondary processes.

7.5.2 Lots to which secondary processing has been performed by any party after sale from the manufacturer must be traceable using a lot number which differs from the manufacturer's original lot number.

7.5.3 If processing that can affect mechanical properties is performed after initial testing, the bolts shall be retested for all specified mechanical properties and performance requirements affected by the processing. This processing includes heat treatment, hot-dip zinc coating and other processing that could affect mechanical properties.

7.5.4 Secondary processing, including lubrication, by any party other than that which certified the assembly lot shall not be permitted on a Twist-Off style bolt assembly lot unless under the direction of the manufacturer.

NOTE 4—Twist-Off Style bolt performance is dependent on the torque/tension relationship and alteration of this relationship may have an adverse effect on performance.

8. Test Methods

8.1 Tensile strength, proof load, surface discontinuities, hardness, micro-hardness, carburization/decarburization, coating thickness, magnetic particle, rotational capacity, assembly tension testing and coating thickness tests, as applicable, shall be in accordance with Table 4.

8.1.1 Tensile strength shall be determined using the F606/F606M Wedge or Axial Tension Testing of Full Size Product Method or the Machined Test Specimens Method depending on size and nominal length as specified in 10.1.

8.1.2 Proof load shall be determined using F606/F606M Method 1, Length Measurement, or Method 2, Yield Strength, at the option of the manufacturer.

8.1.3 Magnetic Particle Inspection shall be conducted on 150 ksi (1040 MPa) bolts, in accordance with Table 4 and 12.1.

8.1.4 Carburization/Decarburization Inspection shall be conducted on 150 ksi (1040 MPa) bolts, in accordance with 12.2.

8.1.5 Rotational Capacity Testing shall be performed on galvanized heavy hex assemblies by the responsible party. Plain finish and other coated heavy hex [illegible]

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TABLE 4 Number of Tests and Test Method or Criteria

	Sample Size (Per Lot)	Test Method Inch	Test Method Metric	Notes
All grades, types, styles				
Tensile Strength	F1470	F606/F606M	F606/F606M	Wedge or axial Full size. Machined. See 8.1.1 and 10.1
Proof Load	F1470	F606/F606M	F606/F606M	Method 1 or 2 optional. See 8.1.2
Hardness	F1470	F606/F606M	F606/F606M	
Dimensions and Thread Fit	ASME B18.18	ASME B18.2.6 B1.1 2A	ASME B18.2.6M B1.13M 6g	
Surface Discontinuities	F1470	F788	F788	
Coating Weight/Thickness	F1470[A]	Product Specification	Product Specification	
150 ksi grades all types and styles				
Magnetic Particle	F1470	F788	F788	Guide E709 or Practice E1444/E1444M
Carburization/Decarburization	At least 1	F2328	F2328M	
All Twist Off assemblies				
Assembly Tension Test (Fastener Tension)	F1470	This standard		
Rotational Capacity	F1470	Annex A2	Annex A2	

[A] Use F1470 for sampling if sample requirements are not in the coating specification.

rotationally capacity tested by the responsible party when specified on the inquiry and purchase order, see Supplementary Requirement S4. Test method is as described in Annex A2.

NOTE 5—Rotational capacity testing of assemblies intended to be installed using a twist-off feature and having been qualified in accordance with Section 11, may offer some limited qualitative information, but does not provide relevant engineering data.

9. Testing and Lot Control

9.1 *Testing Responsibility:*

9.1.1 Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot control and identification quality assurance plan in Sections 9.2 through 9.5.

9.1.2 When supplied by a source other than the manufacturer, the responsible party shall assure all tests have been performed and the bolts conform to this specification.

9.2 Bolts shall be processed in accordance with a lot control and identification quality assurance plan. The manufacturer, secondary processors, and distributors shall identify and maintain the integrity of each production lot from raw material through all processing operations to final packing and shipment. Each lot shall be assigned a unique lot identification number, each lot shall be tested, and the lot inspection test reports retained.

9.3 Secondary processing shall be processed in accordance with a lot control and identification quality assurance plan.

9.4 A lot shall be a quantity of uniquely identified structural bolts of the same nominal size and length produced consecutively at the initial operation from a single mill heat of material and processed at one time, by the same process, in the same manner so that statistical sampling is valid.

9.5 Additional testing for fastener assemblies, such as assembly tension testing and rotational capacity testing also require that the manufacturer or responsible party maintain assembly lot traceability. A unique assembly or rotational capacity lot number shall be created for each change in assembly component lot number, such as nuts or washers.

NOTE 6—The purpose of a lot inspection and control program is to ensure that each lot conforms to this specification and that lot integrity is maintained to the point of use. It is essential that secondary processors, distributors, and users maintain lot identification and integrity until installation.

9.6 *Number of Tests:*

9.6.1 The minimum number of tests required from each lot or each assembly lot shall be according to F1470 and ASME B18.18. These tests and sample numbers are for final inspection only and shall be in addition to the manufacturer's established internal quality control system and in-process inspection procedures.

9.6.2 Disposition of non-conforming product shall be in accordance with F1470 Section 8.

NOTE 7—Section 9.6.1 is intended to identify a statistically large number of non-conformances but does not assure 100% freedom from non-conforming product.

10. Mechanical Properties

10.1 *Tensile Properties:*

10.1.1 Except as permitted in 10.1.2 and 10.1.3, diameters 1 in./M24 and smaller having a nominal length of 2¼ D and longer, and sizes over 1 in./M24 having a nominal length of 3D and longer, shall be wedge tested full size to F606/F606M and shall conform to the wedge tensile load and proof load or alternative proof load specified in Table 5.

10.1.2 Sizes 1 in./M24 and smaller having a nominal length shorter than 2¼ D down to 2D, inclusive, that cannot be wedge tensile tested, shall be axially tension tested full size to F606/F606M and shall conform to the minimum tensile load and proof load or alternate proof load specified in Table 5.

10.1.3 Sizes 1 in./M24 and smaller having a nominal length shorter than 2D and sizes larger than 1 in./M24 with nominal lengths shorter than 3D that cannot be axially tensile tested shall be qualified on the basis of hardness

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