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**MILITARY SPECIFICATION**  
**STUDS, CONTINUOUS THREAD (BOLT STUDS); NUTS, PLAIN,**  
**HEXAGON; AND STEEL BARS, ROUND-HIGH TEMPERATURE**  
**SERVICE**

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

**1. SCOPE**

**1.1 Scope.** - This specification covers steel bolt studs, nuts, and hot rolled and cold finished steel bars for bolt studs for high temperature service. Requirements specified herein for bolt studs apply also to steel "studs" and "stud bolts" procured under this specification.

**1.2 Classification.** - Steel bars, bolt studs, and nuts shall be of the following types, as specified (see 6.2):

**Type I - Bars and bolt studs (alloy steel).**

**Type II - Nuts (carbon steel and alloy steel).**

**1.2.1** Type I and type II materials shall be of the following specific grades, as specified (see 6.2):

**Type I -**

**Grade**

Chromium-molybdenum (identification symbol B7)

Chromium-molybdenum-vanadium (identification symbol B14)

Chromium-molybdenum-vanadium (identification symbol B16)

**Type II -**

**Grade**

Carbon steel (identification symbol H)

Carbon-molybdenum alloy steel (identification symbol 4)

**2. APPLICABLE DOCUMENTS**

**2.1** The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

**SPECIFICATIONS**

**FEDERAL**

- PPP-B-566 - Boxes, Folding, Paperboard.
- PPP-B-576 - Boxes, Wood, Cleated Veneer, Paper Overlaid.
- PPP-B-591 - Boxes, Fiberboard, Wood-Cleated.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Box, Fiberboard.
- PPP-B-643 - Boxes, Folding, Fiberboard, Heavy Duty.
- PPP-B-665 - Boxes; Paperboard, Metal Stayed (Including Stay Material).
- PPP-B-676 - Boxes, Set-Up, Paperboard.

FBC 5307, 5310

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**MILITARY**

- MIL-P-116 - Preservation, Methods of.
- MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application.

**STANDARDS**

**FEDERAL**

- FED-STD-48 - Tolerances for Steel and Iron Wrought Products.
- FED-STD-66 - Steel, Chemical Composition and Hardenability.
- FED-STD-151 - Metals; Test Methods.
- FED-STD-183 - Continuous Identification Marking of Iron and Steel Products.

**MILITARY**

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-109 - Quality Assurance Terms and Definitions.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-163 - Steel Mill Products; Preparation for Shipment and Storage.
- MIL-STD-271 - Nondestructive Testing Requirements for Metals.
- MIL-STD-414 - Sampling Procedures and Tables for Inspection by Variable for Percent Defective.
- MS17980 - Magnetic Particle Indications on Steel Nuts.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

**NATIONAL BUREAU OF STANDARDS**

Handbook B-23 Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

**OFFICIAL CLASSIFICATION COMMITTEE**

Uniform Freight Classification Rules

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York 16, N. Y.)

**AMERICAN SOCIETY FOR TESTING MATERIALS**

A-193 - Specification for Alloy-Steel-Bolting Materials for High-Temperature Service.

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

**3. REQUIREMENTS**

**3.1 Material.-**

3.1.1 The material shall be such as to produce bars, bolt studs, and nuts in compliance with the requirements of this specification.

3.1.2 The steel shall be made by the basic-oxygen, open-hearth, or electric-furnace process.

3.1.3 Chemical composition and mechanical properties. - Bars, bolt studs and nuts shall conform the chemical and mechanical requirements shown in tables I and II.

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Table I - Chemical requirements.<sup>1/</sup>

Type	Identification symbol	Carbon	Manganese	Sulfur (max.)	Phosphorus (max.)	Silicon	Molybdenum	Chromium	Vanadium
		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
I - Bars and bolt studs	B7	0.36-0.50	0.71-1.04	0.045	0.045	0.18-0.37	0.13-0.27	0.75-1.15	---
	B14	.39-.51	.42-.73	.045	.045	.18-.37	.28-.42	.75-1.20	0.17-0.33
	B16	.33-.47	.37-.73	.045	.045	.18-.37	.42-.68	.75-1.20	.22-.38
II - Nuts	H	---	---	.050	.050	---	---	---	---
	4	.40-.50	.50-.95	.050	.040	.15 (min.)	.20 (min.)	---	---

<sup>1/</sup>Steel to which lead has been added shall not be used.Table II - Mechanical requirements after heat treatment.<sup>1/</sup>(see 3.2.4)

Type	Identification symbol	Tensile strength (min.)	Proof stress (min.)	Yield point <sup>2/</sup> (min.)	Elongation in 2 inches (min.)	Reduction of area (min.)	Surface Brinell <sup>3/</sup> or Rockwell <sup>4/</sup> hardness number
		P. s. i.	P. s. i.	P. s. i.	Percent	Percent	
I - Bars and bolt studs <sup>5/</sup> (alloy steel)	B7	125,000	---	105,000	18.0	50.0	255-321 Brinell hardness or 25-34 Rockwell C hardness <sup>6/</sup>
	B14	125,000	---	105,000	18.0	50.0	255-321 Brinell hardness or 25-34 Rockwell C hardness <sup>6/</sup>
	B16	125,000	---	105,000	18.0	50.0	255-321 Brinell hardness or 25-34 Rockwell C hardness <sup>6/</sup>
II - Nuts (carbon and alloy steel)	H(finished)	---	135,000	---	---	---	160 Brinell hardness or 84 Rockwell B hardness (min.)
	H(heavy)	---	150,000	---	---	---	
	4(finished)	---	150,000	---	---	---	248-352 Brinell hardness or 24-38 Rockwell C hardness
	4(heavy)	---	175,000	---	---	---	

<sup>1/</sup>Sizes 2-1/2 inch and smaller. For sizes larger than 2-1/2 inch diameter, the mechanical requirements of ASTM-A-193 shall apply.<sup>2/</sup>Where a definite yield point is not exhibited, the yield strength corresponding to a limiting offset of 0.2 percent of the gage length shall be used.<sup>3/</sup>Brinell hardness-10mm. standard steel ball, 3000kg. load. When a 3000kg. load deforms the nut, a minor load, Brinell or the Rockwell hardness test, shall apply.<sup>4/</sup>Rockwell B hardness - 1/16 inch ball, 100kg. load. Rockwell C hardness - Diamond (Brale), 150kg. load.<sup>5/</sup>Finished bolt studs tested in full size shall meet the tension test load of table V (see 4.3.2.2(a)) within the capacity of a 125,000-pound testing machine.<sup>6/</sup>See 4.3.2.1(b) and 4.3.2.2(b).

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**3.2 Bars for bolt studs.** - Bars for bolt studs may be either hot rolled or cold finished.

**3.2.1 Freedom from scale.** - Bars shall be free from scale which would interfere with the detection of defects by visual and magnetic examination or would interfere with the manufacture of bolt studs and nuts.

**3.2.2 Injurious defects.** - Bars shall be sound, of uniform quality and condition, free from pipe, and shall not contain laps, cracks, seams, slivers and other defects, as indicated by visual, magnetic analysis, or magnetic particle examination (see 4.4.1 and 4.4.2), detrimental to the manufacture and performance of bolt studs produced therefrom.

**3.2.3 Dimensions.** -

**3.2.3.1 Diameter.** - The diameter of bars shall not vary from the specified dimensions by more than the amounts shown in FED-STD-48 for hot rolled or cold finished alloy or carbon steel bars, as applicable.

**3.2.3.2 Length.** -

**3.2.3.2.1 Exact lengths.** - When exact lengths are specified (see 6.2), the length tolerances shall be as follows:

- (a) For lengths 12 feet and less: Plus 3/16 inch, minus 1/16 inch.
- (b) For lengths over 12 to 25 feet, inclusive: Plus 1/4 inch minus 1/16 inch.

**3.2.3.2.1.1** When a unilateral length tolerance is specified, all plus or all minus, the tolerance allowed shall be the total of the plus and minus tolerances specified in 3.2.3.2.1.

**3.2.3.2.2 Stock lengths.** - When alloy steel bars are ordered in stock lengths, the hot cutting length tolerances of FED-STD-48 are applicable. However, some shorter lengths will be acceptable providing length and number of such short lengths conform to the permissible variations shown in table III.

Table III - Permissible variation in length of round, hot-rolled alloy steel bars.

Nominal stock length	Shortest acceptable length	Maximum permissible percentage by weight of short lengths
Feet	Feet	Percent
20	12	80
18	10	80
16	10	80
14	8	80
12	8	40
10	8	40
8	6	40
6	4	40

**3.2.4 Heat-treatment.** - The bars shall be quenched from within the austenitizing range and then tempered at the following minimum temperatures:

Material	Minimum tempering temperature
B7-Chromium-molybdenum alloy steel	1100°F.
B14, B16-Chromium-molybdenum-vanadium alloy steel	1200°F.

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3.2.4.1 Stress-relief after straightening will be permitted. Normalizing followed by tempering at 1200°F. minimum will be permitted for B14 bars.

3.2.5 Post heat-treatment processing. - Hot-rolled or cold finished alloy steel bars which have been liquid quenched and tempered in accordance with 3.2.4 shall be straightened and descaled as necessary (see 3.2.1) and examined by magnetic analysis methods (see 4.3.4.1 and 4.4.1.1).

3.2.6 Heat-treatment records. - The supplier shall, when requested, furnish the procuring activity records of all heat treatments (see 6.2).

3.2.7 Marking for identification. - Each bar 2 inches and over in diameter shall be legibly die stamped or paint stenciled in accordance with FED-STD-183, identification symbol "B7", "B14" or "B16", as applicable, the specification number the manufacturer's name or trade-mark, and the heat or melt number. For bars under 2 inches in diameter which may be shipped in secured lifts or bundles, the above information shall be on a substantial tag securely affixed to each end of each secured lift or bundle with a third tag placed inside the bundle near the middle. The tags on lifts and bundles shall be of a material capable of withstanding the rigors of handling, transportation, and storage without being destroyed.

### 3.3 Type I, bolt studs (alloy steel). -

3.3.1 Bar stock. - Either hot-rolled or cold-finished bars may be used for the production of bolt studs.

3.3.2 Steel quality. - Bolt studs shall be of uniform quality and condition, free from rust, and shall not contain fins, seams, or other injurious defects detrimental to the performance of parts.

3.3.3 Finish. - Bolt studs shall be finished and threaded full length. Both ends shall be rounded, or flat and chamfered, at the option of the supplier. When flat and chamfered, the diameter of the flat shall not exceed the minor diameter of the thread.

3.3.4 Manufacture. - Unless otherwise specified (see 6.2), the method of producing screw threads shall be by chasing, milling, grinding, die cutting, or rolling.

3.3.5 Thread series. - The limiting dimensions and tolerances for threads shall conform to those given in H28. Unless otherwise specified (see 6.2), threads shall be Unified Coarse Thread Series, Class 2A tolerances in sizes 1/4 through 1 inch, and Unified 8-Pitch Series, Class 2A in sizes over 1 inch (see table IV).

Table IV - Thread series.

Unified UNC-2A (Bolt studs) UNC-2B (nuts)		Unified 8(UN)2A (Bolt studs) 8(UN)2B (Nuts)	
Size	Threads per inch	Size	Threads per inch
Inch		Inches	
1/4	20	1-1/8	8
5/16	18	1-1/4	8
3/8	16	1-3/8	8
7/16	14	1-1/2	8
1/2	13	1-5/8	8
9/16	12	1-3/4	8
5/8	11	1-7/8	8
3/4	10	2	8
7/8	9	2-1/4	8
1	8	2-1/2	8

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**3.3.6 Length, length tolerance, and diameter.** - The length and nominal diameter of the bolt studs shall be as specified (see 3.3). Length of stud is measured as overall length (see figure 1). Tolerance for lengths 12 inches and under shall be plus or minus 1/16 inch; for lengths over 12 inches to 18 inches, inclusive, shall be plus or minus 1/8 inch; and for lengths over 18 inches, shall be plus or minus 1/4 inch.

**3.3.7 Tension loads.** - The tension test loads for finished bolt studs shall be as shown in table V.

Table V - Minimum test loads for bolt studs.

Nominal size	Mean tensile stress area <sup>1/</sup>	Tensile load <sup>2/</sup>
Inches	Square inches	Pounds
1/4	0.0318	4,000
5/16	.0524	6,600
3/8	.0775	9,700
7/16	.1063	13,300
1/2	.1419	17,700
5/8	.182	22,800
3/4	.228	28,300
7/8	.284	35,800
1	.352	44,500
1-1/8	.432	54,800
1-1/4	.524	66,600
1-3/8	.628	79,800
1-1/2	.744	94,500
1-5/8	.872	110,500
1-3/4	1.012	128,000
1-7/8	1.164	147,000
2	1.328	168,000
2-1/8	1.504	191,000
2-1/4	1.692	216,000
2-1/2	1.892	243,000

<sup>1/</sup>Based on Handbook H-28 formula.

<sup>2/</sup>Based on tensile strength of 125,000 p. s. i.

**3.3.8 Marking.** - Each bolt stud shall be legibly die stamped as shown on figure 1 with the manufacturer's name or trademark and with identification symbol "B7", "B14" or "B16", as applicable (see 3.1.3 and 6.1.3).

**3.4 Type II, nuts (carbon steel, symbol H; and carbon-molybdenum alloy steel, symbol 4.**

**3.4.1 Manufacture.** - Nuts shall be made by hot or cold forging or hot punched, and heat treated to conform to table II. Nuts machined from rolled or drawn bar steel are unacceptable.

**3.4.2 Quality.** - Nuts shall be sound, of uniform quality and condition and free from cracks and excessive laps, seams or other defects indicated by test and examination specified in 4.5.4 and 4.5.6 and shall be free from scale or rust.

**3.4.3 Finish series.** - Nuts shall be finished hexagon series or heavy semifinished hexagon series as specified (see 6.2). Finished nuts shall be in conformity with table VI and notes thereof. Heavy semifinished nuts shall be in conformity with table VII and notes thereof.

**3.4.4 Heat treatment.** - Symbol H nuts shall be quenched from within the austenitizing range and then tempered at not less than 850°F. Symbol 4 nuts shall be quenched from within the austenitizing range and

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then tempered at not less than 1100°F.

3.4.5 Thread series. - The limiting dimensions shall conform to those given in H-28. Unless otherwise specified (see 6.2), threads shall be Unified Course Thread Series, Class 2B tolerances in sizes 1/4 through 1 inch, and Unified 8-Pitch Series, Class 2B in sizes over 1 inch (see table IV).

3.4.6 Dimensions. - The dimensions of the nuts shall be as shown in table VI or table VII according to specified finish series (see 6.2 and 6.4).

Table VI - Dimensions of finished <sup>1/</sup> hexagonal nuts.

Nominal size	Width across flats <sup>2/</sup>		Width across corners (minimum)	Thickness <sup>3/</sup>		
	Maximum	Minimum		Nominal	Maximum	Minimum
Inches	Inches	Inches	Inches	Inches	Inches	Inches
1/4	0.4375	0.428	0.488	7/32	0.226	0.212
5/16	.5000	.489	.557	17/64	.273	.258
3/8	.5625	.551	.628	21/64	.337	.320
7/16	.6875	.675	.768	3/8	.385	.365
1/2	.7500	.738	.840	7/16	.448	.427
9/16	.7850	.861	.982	31/64	.496	.473
5/8	.9375	.922	1.051	35/64	.559	.535
3/4	1.1250	1.088	1.240	41/64	.665	.617
7/8	1.3125	1.289	1.447	3/4	.776	.724
1	1.5000	1.450	1.653	55/64	.887	.831
1-1/8	1.6875	1.631	1.859	31/32	.999	.939
1-1/4	1.8750	1.812	2.066	1- 1/16	1.094	1.030
1-3/8	2.0625	1.994	2.273	1-11/64	1.206	1.138
1-1/2	2.2500	2.175	2.480	1- 9/32	1.317	1.245
1-5/8	2.4375	2.356	2.686	1-25/64	1.429	1.353
1-3/4	2.6250	2.538	2.893	1- 1/2	1.540	1.460
1-7/8	2.8125	2.719	3.100	1-39/64	1.651	1.567
2	3.0000	2.900	3.306	1-23/32	1.763	1.675
2-1/4	3.3750	3.262	3.719	1-59/64	1.970	1.874
2-1/2	3.7500	3.625	4.133	2- 9/64	2.193	2.089

<sup>1/</sup>"Finished" in the title refers to general overall dimensions and does not indicate that the surfaces are completely machined.

<sup>2/</sup>Width across flats. -

- The width across flats of nuts shall be measured at the widest point.
- Taper of the sides of nuts (angle between one side and the axis) shall not exceed 2 degrees, the specified width across the flats being the largest dimension.

<sup>3/</sup>Thickness:

- The thickness of the nut shall be the distance from the top to the bearing surface.
- Tops of nuts shall be flat and chamfered.
- The angle of chamfer with the top surface shall be 30 degrees.
- The outer diameter of the top circle shall be the maximum width across the flats within a tolerance of minus 15 percent.
- The bearing surface shall be washer faced.
- The thickness of the washer shall be approximately 1/64 inch.
- The outer diameter of circle of bearing surface shall be the maximum width across flats within a tolerance of minus 5 percent.
- The bearing surface shall be at right angles to the axis of the threaded hole within a tolerance of 2 degrees for 5/8 inch nuts and smaller, and 1 degree for nuts larger than 5/8 inch.
- The tapped hole shall be countersunk 1/64 inch over the major diameter of thread for nuts up to and including 1/2 inch, and 1/32 inch over the major diameter of thread for nuts over 1/2 inch size.

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Table VII - Dimensions of heavy semifinished hexagonal nuts.

Nominal size	2/ Width across flats		Width across corners (minimum)	3/ Thickness		
	Maximum	Minimum		Nominal	Maximum	Minimum
Inches	Inches	Inches	Inches	Inches	Inches	Inches
1/4	0.5000	0.488	0.555	15/64	0.250	0.248
5/16	.5625	.548	.622	19/64	.314	.310
3/8	.6875	.669	.763	23/64	.377	.371
7/16	.7500	.728	.810	27/64	.441	.433
1/2	.8750	.850	.969	31/64	.504	.494
9/16	.9375	.909	1.037	35/64	.568	.556
5/8	1.0625	1.031	1.175	39/64	.631	.617
3/4	1.2500	1.212	1.367	47/64	.758	.740
7/8	1.4375	1.394	1.589	55/64	.885	.863
1	1.6250	1.575	1.798	63/64	1.012	0.986
1-1/8	1.8125	1.756	2.007	1- 7/64	1.139	1.109
1-1/4	2.0000	1.938	2.209	1- 7/32	1.266	1.233
1-3/8	2.1875	2.119	2.414	1-11/32	1.393	1.356
1-1/2	2.3750	2.298	2.622	1-15/32	1.520	1.479
1-5/8	2.5625	2.481	2.828	1-19/32	1.647	1.599
1-3/4	2.7500	2.667	3.037	1-23/32	1.774	1.723
1-7/8	2.9375	2.844	3.243	1-27/32	1.901	1.846
2	3.1250	3.025	3.449	1-31/32	2.028	1.970
2-1/4	3.5000	3.388	3.867	2-13/64	2.251	2.189
2-1/2	3.8750	3.750	4.275	2-29/64	2.505	2.431

1/ "Semifinished" in the title refers to general overall dimensions and does not indicate surface condition.

2/ Width across flats:

- The width across flats of nuts shall be measured at the widest point.
- Taper of the sides of nuts (angle between one side and the axis) shall not exceed 2 degrees, the specified width across the flats being the largest dimension.

3/ Thickness:

- The thickness of the nut shall be the distance from the top to the bearing surface.
- Tops of nuts shall be flat and chamfered.
- The angle of chamfer with the top surface shall be 30 degrees.
- The outer diameter of the top circle shall be the maximum width across the flats within a tolerance of minus .5 percent.
- The bearing surface shall be washer faced.
- The thickness of the washer shall be approximately 1/64 inch.
- The outer diameter of circle of bearing surface shall be the maximum width across flats within a tolerance of minus .5 percent.
- The bearing surface shall be at right angles to the axis of the threaded hole within a tolerance of 2 degrees for 1/8 inch nuts and smaller, and 1 degree for nuts larger than 5/8 inch.
- The tapped hole shall be countersunk 1/64 inch over the major diameter of thread for nuts up to and including 1/2 inch, and 1/32 inch over the major diameter of thread for nuts over 1/2 inch size.

3.4.7 Marking. - Each nut shall be legibly die stamped on the top face as shown on figure 2 with manufacturer's name or trademark and with identification symbol "H" or "4", as applicable (see 3.1.3 and 6.1.3). Each nut, after having been subjected to magnetic particle examination and found to be free of major defect as specified in MS17980 shall be marked with a groove approximately 1/16-inch wide by 1/32-inch deep, abrasive-wheel cut flat-to-flat across the crown.



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**3.5 Workmanship.** - The workmanship shall be such as to produce bars, bolt studs and nuts conforming to the quality requirements specified in 3.2.1, 3.2.2, 3.3.2 and 3.4.2.

#### 4. QUALITY ASSURANCE PROVISIONS

**4.1 Responsibility for inspection.** - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

#### 4.2 Lot.

**4.2.1 Material identifiable by melt.** - If the material is identifiable by melt, a lot shall consist of all bars, or bolt studs or nuts of the same nominal size produced from the same heat and heat-treated in the same batch or by a continuous process under the same conditions as to time and temperature.

**4.2.2 Material not identifiable by melt.** - If the material is not identifiable by melt a lot shall consist of not more than 2000 pounds of bars, or 1000 pounds of bolt studs or 1000 pounds of nuts, of the same nominal size heat-treated in the same batch or by a continuous process under the same conditions of time and temperature.

#### 4.3 Sampling for quality conformance inspection.

**4.3.1 Sampling for chemical analysis.** - From each lot two samples for chemical analysis shall be selected and prepared in accordance with FED-STD-66. The samples shall be selected from different pieces in the lot and shall be kept separate. The samples shall be forwarded to a laboratory satisfactory to the procuring activity for chemical analysis.

#### 4.3.2 Sampling for mechanical and physical tests.

**4.3.2.1 Bar stock.** - From each lot of bars samples shall be selected for test in accordance with the following schedule:

- (a) **Tension test.** - Two samples for tension test shall be selected from different bars.
- (b) **Hardness test.** - The samples cut for tension test shall be used for surface hardness test of bars identifiable by melt. Where practicable, these pieces may also be used for measurement of internal hardness; and where such is not practicable, short pieces of suitable length, (thick disks), cut from adjacent bar stock may be used. Each bar not identifiable by melt shall be tested for surface hardness. The two bars having the lowest surface hardness shall be selected for tension and internal hardness testing. The two bars having the highest surface hardness shall be selected for internal hardness test (see 4.5.3.1). Pieces of suitable length (thick disks) cut from bar ends may be used for internal hardness measurement.

**4.3.2.2 Bolt studs.** - Except for bolt studs machined for heat-treated bars conforming to the tensile requirements of table II and all other applicable requirements of this specification, samples for test shall be selected from each lot in accordance with the following schedule:

- (a) **Minimum breaking load tension test.** - Three samples for tension test shall be selected.
- (b) **Hardness test.** - Where bolt studs are not identifiable for melt, sample bolt studs shall be selected at random from each lot in accordance with MIL-STD-414 at Inspection Level IV. The hardness test values for these sample bolt studs shall be used as shown in Section B of MIL-STD-414 to obtain an estimate of the percentage of bolt studs outside the permissible limits. The acceptable quality level shall be 0.65 percent.

**4.3.2.3 Nuts.** - From each lot of nuts, samples for test shall be selected in accordance with the following schedule:

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- (a) Hardness test. - The lot size shall be expressed in pounds. The sample size, quantity of nuts to be tested, shall be as shown in table VIII. The acceptable quality level shall be 2.5 percent defective computed in accordance with Section B of MIL-STD-414.
- (b) Cone stripping test. - The sample nuts tested for hardness shall be used for the cone stripping test.

Table VIII - Test sample for nuts.

Pounds	Quantity of nuts per sample
Up to 300	3
301 to 500	4
501 to 900	5
901 to 1,300	7
1,301 to 3,200	10
3,201 to 8,000	15
8,001 to 22,000	20
22,001 to 110,000	25

4.3.3 Sampling for dimensional examination. -

4.3.3.1 Bar stock. - Sample bars shall be selected in accordance with MIL-STD-414 at Inspection Level III. The acceptable quality level shall be 2.5 percent defective.

4.3.3.2 Bolt studs and nuts. - From each lot of bolt studs and nuts, a random sample for dimensional examination shall be selected in accordance with MIL-STD-414 at Inspection Level III. The acceptable quality level shall be 2.5 percent defective.

4.3.4 Sampling for visual, magnetic analysis, and magnetic particle examination.

4.3.4.1 Bar stock. - All bars in a lot shall constitute the sample for visual examination and magnetic analysis examination.

4.3.4.2 Bolt studs. - Except for bolt studs machined from heat-treated bars which have been examined by magnetic analysis and found acceptable, samples for magnetic particle examination shall be selected at random from each lot in accordance with MIL-STD-105. Inspection Level III shall be used for lots containing from 2 to 300 pieces, and Inspection Level II for lots containing more than 300 pieces. The acceptable quality level shall be 0.65 percent defective. Bolt studs machined from bars examined by magnetic analysis and found acceptable, and otherwise conforming to requirements for bars specified herein, need not be sampled for magnetic particle examination.

4.3.4.3 Nuts for magnetic particle examination. - All nuts in the lot constitute the sample for magnetic particle examination.

4.3.5 Sampling for inspection of preparation for delivery. - Sampling and inspection procedures of MIL-P-116 shall be employed to verify conformance to the requirements of Section 5 of this specification.

4.4 Examination. - Each sample selected in accordance with 4.3.3 through 4.3.4.3, inclusive, shall be examined to determine conformance with the requirements of this specification for surface finish and defects (see 4.4.2), thread dimensions (see 4.4.3.2), marking and workmanship. The classification of possible defects and quality nonconforming characteristics in table DX shall constitute the minimum quality suitable for the intended uses stipulated in 6.1.

4.4.1 Magnetic examination. -

4.4.1.1 Bar stock. - Bars shall be examined by magnetic analysis for defects. The magnetic analysis equipment shall, before each examination, be adjusted to indicate seams and cracks. In lieu of magnetic analysis, magnetic particle examination of bars for seams and cracks is acceptable. Each nonconforming bar shall not be offered for delivery.

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Table EX - Classification of defects and quality nonconforming characteristics in accordance with Standard MIL-STD-109.

Categories	Defects
<b>Critical:</b> 1	None defined.
<b>Major:</b> 101	Type not as specified.
102	Material not type specified; not free from pipe, laps, cracks, seams, fins, scale rust, or other injurious defects.
103	Thread not conforming to gage requirements (except bars).
104	Thread damaged (except bars).
105	Thread incomplete or not full length of bolt stud (bolt studs only).
106	Diameter of flat on end of bolt stud exceeds minor diameter of thread (round end bolt studs excluded).
107	Length of bolt stud not within the specified tolerance.
108	Nut not machined, not forged or cold processed as required (type II only).
109	Nut not washer faced as required; face not square with axis of hole within the specified tolerance, thickness of washer not as required or diameter not within specified limits (type II only).
110	Nut not hexagonal shape; top not flat and chamfered as specified (type II only).
111	Nut thickness and width across flats not within the required limits; width across corners less than the allowable minimum (type II only).
112	Bar not straight.
113	Diameter of bar not within specified limits.
114	Length of bar when applicable, not within required limits; or length exceeds nominal or stock specified, or length less than shortest acceptable length (bars only).
115	A metal discontinuity or pattern of discontinuities shown as a major defect in MS17930.
<b>Minor:</b> 201	Radius at one end missing, damaged or not as specified (bolt studs only).
202	Marking, manufacturer's name or trademark and identification symbol missing, incorrect, illegible or not stamped and located as required (except bars).
203	A metal discontinuity or pattern of discontinuities shown as a minor defect in MS17930.
204	Marking, identification symbol, specification number, manufacturer's name or trademark and heat or melt number, missing, incorrect, illegible, tag to each bundle as applicable (bars only).

4.4.1.2 **Bolt studs.** - The sample bolt studs selected in accordance with 4.3.4.2 shall be magnetic particle examined for the presence of injurious defects such as seams and cracks. Any piece in the sample containing one or more defects shall be considered a defective and shall not be offered for delivery. If the number of defectives found in the sample equals or exceeds the rejection number in MIL-STD-105 for the sampling plan used, this shall be cause for rejection of the entire lot.

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4.4.2 Visual examination. -

4.4.2.1 Bar stock. - Each bar in the lot shall be visually examined for identification marking, the presence of cracks, seams, slivers, and other injurious defects. Bars containing injurious defects shall not be offered for delivery.

4.4.2.2 Bolt studs and nuts. - The bolt studs and nuts selected in accordance with 4.3.4.2 and 4.3.4.3 shall be visually examined for the presence of injurious defects such as seams, cracks, and defective threads. Any piece in the sample containing one or more defects shall be considered a defective and shall not be offered for delivery. If the number of defectives found in the sample equals or exceeds the rejection number shown in MIL-STD-105 for the sampling plan used, this shall be cause for rejection of the lot.

4.4.3 Dimensional examination. -

4.4.3.1 Bar stock. - Bars selected in accordance with 4.3.3.1 shall be measured to determine conformance with the diameter and length requirements (see 3.2.3.1 and 3.2.3.2 and table III).

4.4.3.2 Bolt studs and nuts. - The sample selected in accordance with 4.3.3.2 shall be examined by means of gages and other measuring instruments to determine conformance with the threading and dimensional requirements (see 3.3.5 and 3.3.6). Gaging shall be performed as described in 4.4.3.3.2. Any nut or bolt stud found in the sample that does not conform to the requirements of this specification for dimensions or threading shall not be offered for delivery. If the number of nonconforming bolt studs or nuts found in the sample equals or exceeds the rejection number shown in MIL-STD-414 for the plan used, this shall be cause for rejection of the lot.

4.4.3.3 Inspection gages. -

4.4.3.3.1 Availability. - Unless otherwise specified (see 6.2), the supplier shall make available the necessary inspection gages. The accuracy of the gages shall be certified. In case of controversy, the certification of the National Bureau of Standards shall govern.

4.4.3.3.2 Thread gages. - screw threads shall be gaged by means of thread ring and plug gages and smooth ring and plug gages, as applicable, in accordance with the practices recommended in B28.

4.5 Tests.

4.5.1 Chemical analysis. - The samples selected in accordance with 4.3.1 shall be analyzed in accordance with method III of FED-STD-151 to determine compliance with table I. Each sample shall be analyzed separately.

4.5.2 Tension tests. -

4.5.2.1 Bar stock. - Each of the samples selected in accordance with 4.3.2.1(a) shall be machined to the form and dimensions of type R1 or type R2 specimen of FED-STD-151, method 211, and shall be pulled in tension to determine compliance with table II. The tension test shall be made in accordance with FED-STD-151. When no definite yield point is exhibited, the yield strength shall be determined by the offset method specified in FED-STD-151 at an offset of 0.2 percent of the gage length.

4.5.2.2 Bolt studs. -

4.5.2.2.1 Minimum breaking load tension test. - The sample bolt studs selected in accordance with 4.3.2.2(a) shall be tested in tension to determine compliance with table V. The bolt studs shall meet the requirements of table V without visual evidence of failure. If failure occurs by stripping of the threads prior to reaching the minimum breaking load, the test shall be considered inconclusive, the sample discarded, and another sample selected for test.

4.5.2.2.1.1 Test procedure. - The minimum breaking load test shall be made on finished bolt studs with the load applied between nuts or suitable fixtures, either of which have sufficient thread engagement to develop the full strength of the bolt stud. The nuts or fixtures shall be assembled freely toward the center of the bolt stud and then backed off leaving at least 12 complete stud threads exposed and unengaged between the grips.

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4.5.2.2.1.2 Turned or ground specimens. - When test equipment of sufficient capacity is not available for testing bolt studs to 3/4 inch exclusive, in full size as described in 4.5.2.2.1, tests shall be made as follows: Bolt studs 3/4 to 1-3/8 inch in diameter, inclusive, shall have their shanks concentric with the axis of the screw as shown in figure 3. For bolt studs over 1-3/8 inch in diameter a type R1 specimen in accordance with FED-STD-151, method 211, shall be turned or ground from the bolt stud. The axis of the specimen shall be midway between the center and outside surface as shown on figure 4. The specimens shall be pulled in tension to determine compliance with table II.

4.5.3 Hardness test. - Brinell or Rockwell hardness tests shall be made on the samples selected in accordance with 4.3.2.1(b), 4.3.2.2(b), and 4.3.2.3(a) to determine compliance with table II. Where the minimum requirements are the subject of controversy and both hardness and tension tests are performed, tension test results shall take precedence.

4.5.3.1 Bar stock. - For bar stock the surface hardness reading shall be taken as near the end of the bar as feasible. However, the distance of the center of the indentation from the end or edge of the bar or from the center of another indentation shall be not less than three times the diameter of the indentation. Internal hardness measurements shall be made on saw-cut ends or on the saw-cut surfaces of short lengths (thick disks) specified in 4.3.2.1(b). Measurement shall be made by indentation at the approximate center and another at approximately midway between the center and the periphery.

4.5.3.2 Bolt studs. - Hardness readings shall be taken on either end of the studs.

4.5.3.3 Nuts. - Rockwell hardness of nuts shall be determined on the top or bottom of the nut. Brinell hardness shall be determined on the side of the nut. Either method may be used at the option of the supplier taking into account the limitations of these hardness tests as set forth in methods 243 and 242, respectively, of FED-STD-151. When the standard Brinell hardness test causes deformation of the nut, it will be necessary to use a minor load, or substitute a Rockwell hardness test.

4.5.4 Cone stripping test. - The sample nuts selected in accordance with 4.3.2.3(b) shall be tested as follows: The test nut and stud, with a free-sliding hardened conical washer in place, shall be assembled by mutual thread engagement, fixed in a test machine, and subjected to the axial proof load specified in table X applied to the nut through the washer (see figure 5). The nut shall resist this load without stripping or rupture. Stress loading shall be applied at a uniform rate such that full load is reached at a minimum time of 30 seconds, maintained at full load, minimum, for one minute and then released.

Table X - Cone stripping proof load of nuts.

Nominal size, threads per inch, and series designation	Tensile stress area <sup>1/</sup> (square inch)	Proof load, minimum (pounds)			
		Grade H Finished <sup>2/</sup>	Grade H Heavy <sup>3/</sup>	Grade 4 Finished <sup>4/</sup>	Grade 4 Heavy <sup>4/</sup>
1/4 - 20 UNC	0.0318	4,000	4,400	5,150	5,150
5/16 - 18 UNC	.0524	6,400	7,100	8,300	8,300
3/8 - 16 UNC	.0775	9,300	10,300	12,000	12,000
7/16 - 14 UNC	.1063	12,500	13,900	16,150	16,150
1/2 - 13 UNC	.1419	16,300	18,100	21,100	21,100
9/16 - 12 UNC	.182	20,400	22,700	26,500	26,500
5/8 - 11 UNC	.228	24,800	27,500	32,150	32,150
3/4 - 10 UNC	.284	34,900	38,800	45,300	45,300
7/8 - 9 UNC	.462	46,000	51,100	59,650	59,650
1 - 8 UNC	.606	57,300	63,600	74,250	74,250
1-1/8 - 8 UN	.790	70,700	78,500	91,600	91,600
1-1/4 - 8 UN	1.000	84,400	93,700	109,350	109,350
1-3/8 - 8 UN	1.233	97,800	108,700	126,850	126,850
1-1/2 - 8 UN	1.492	110,800	123,100	143,600	143,600

<sup>1/</sup> Based on formula given in 4.5.4.1.

<sup>2/</sup> Based on proof stress of 135,000 p. s. i.

<sup>3/</sup> Based on proof stress of 150,000 p. s. i.

<sup>4/</sup> Based on proof stress of 175,000 p. s. i. (see 6.4).

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**4.5.4.1 Calculation of cone stripping proof load.** - For purposes of computing the cone stripping proof load of the nut, the following formula shall be used:

$$CPL = (1 - 0.30D) \times f \times A_s$$

Where:

CPL = Cone stripping proof load in pounds.

D = Nominal diameter of nut in inches.

f = Minimum proof stress of nut in pounds per square inch (see notes 2 and 3 of table X).

A<sub>s</sub> = Tensile stress area of nut in square inches.

$$0.7854 \left( D - \frac{0.9743}{n} \right)^2$$

n = Threads per inch.

**4.5.5 Possible test failures.** - Possible test failures are defined as follows:

- (a) **Chemical analysis.** -
  - (1) Chemical composition not as specified.
- (b) **Minimum breaking load tension test (bolt studs only).** -
  - (1) Evidence of failure prior to reaching the specified minimum breaking load when tested as required.
- (c) **Hardness test.** -
  - (1) Hardness not within the specified range (type I only).
  - (2) Hardness less than the allowable minimum range not within the specified range as applicable (type II only).
- (d) **Cone stripping tests (type II only).** -
  - (1) Threads of nut strip or fracture occurs when assembled to test stud and subjected to the specified proof load.
- (e) **Tension test (bars only).** -
  - (1) Tensile strength less than minimum value.
  - (2) Yield point or strength less than minimum value.
  - (3) Elongation less than minimum percentage.
  - (4) Reduction of area less than minimum percentage.
- (f) **Weight of short length (when applicable) (bars only).** -
  - (1) Short lengths exceed the maximum permissible percentage.

**4.5.6 Magnetic particle examination.** - Each nut shall be subjected to magnetic particle examination in accordance with MIL-STD-271 and MSI7980.

#### 4.6 Rejection.

**4.6.1 For 100-percent examination.** - When all pieces in a lot are examined, the defective items shall not be offered for delivery.

**4.6.2 For MIL-STD-105.** - When sampling is performed in accordance with MIL-STD-105, cause for rejection of the lot shall be governed by the requirements of the sampling plan used.

**4.6.3 Other samples.** - If one or more of the samples fails to conform to the applicable requirements of this specification when other samples are selected for tests, this shall be cause for rejection of the entire lot.

**4.7 Retests.** - Retests shall be in accordance with FED-STD-151.

### 5. PREPARATION FOR DELIVERY

**5.1 Domestic shipment and early material installation.** -

**5.1.1 Bolt studs, nuts, and bars.** -

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**5.1.1.1 Preservation and packaging.** - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

**5.1.1.2 Packing.** - Packing shall be accomplished in a manner which will insure acceptance by common carrier and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules and Regulations or other carrier regulations as applicable to the mode of transportation.

**5.1.1.3 Marking.** - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, type, grade, size, contract or order number, contractor's name and destination.

**5.2 Domestic shipment and storage or overseas shipment.** - The requirements and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.2).

(5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made by a Government activity (see 6.2).)

**5.2.1.1 Preservation and packaging.** - Preservation and packaging shall be Level A or C as specified (see 6.3).

**5.2.1.1.1 Level A.** -

**5.2.1.1.1.1 Preservation.** - Bolt studs and nuts shall be cleaned, dried, and immediately thereafter coated with grade 4 preservative of MIL-C-16173. Items coated with preservative do not require a wrap of greaseproof barrier material when the preservative has been allowed to set.

**5.2.1.1.1.2 Packaging.** - Bolt studs, and nuts in the quantity specified in table XI, shall be packaged in folded cartons, set-up, fiberboard or metal edge boxes conforming to PPP-B-566, PPP-B-576, PPP-B-636 or PPP-B-665, respectively, at the option of the contractor.

**5.2.1.1.1.2.1** Gross weight of cartons or boxes shall not exceed the applicable weight limitations of the box specifications. Fiberboard boxes with a minimum Mullen test of 175 or 200 pounds shall not exceed 20 and 45 pounds, respectively. Quantities of bolts and nuts specified in table XI exceeding a net weight of 45 pounds shall be bulk packed and the unit container shall meet the requirements set forth for shipping containers.

Table XI - Quantity of bolt studs and nuts per container.

Nominal sizes	Quantity	
	Bolt studs	Nuts
Inches		
1/4 to 3/8, incl.	100	100
7/16 to 5/8, incl.	50	50
3/4	25	50
7/8	25	25
1 (studs to 4-3/4 inch length, incl.)	20	25
1 (studs over 4-3/4 inch length to 6 inch length, incl.)	16	25
1-1/8 to 1-3/8, incl.	bulk	20
Over 1-3/8	bulk	bulk

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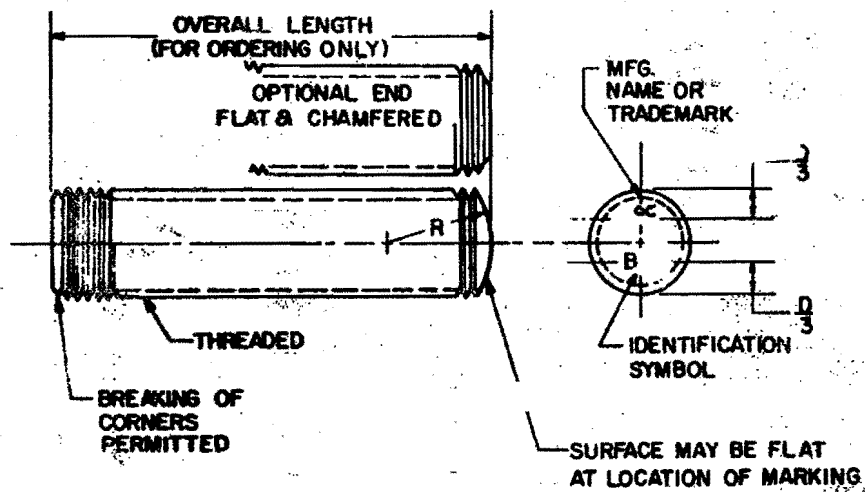


Figure 1 - Marking of bolt studs (marking may be on either end).

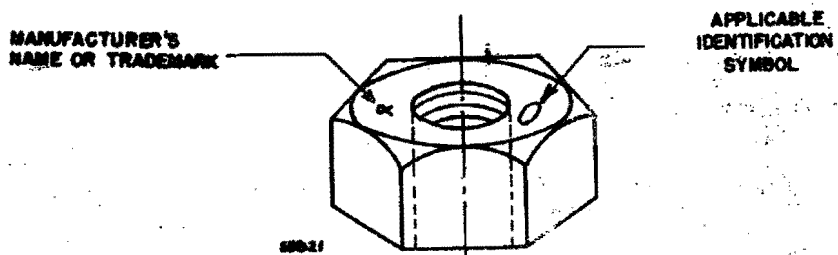


Figure 2 - Marking of nut (marking may be at any position on top of nut; marking of nut on the side is not permitted).



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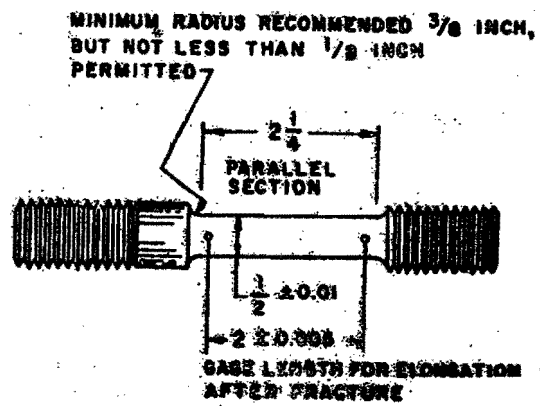


Figure 3 - Tension test specimen for bolt stud turned down at one end.

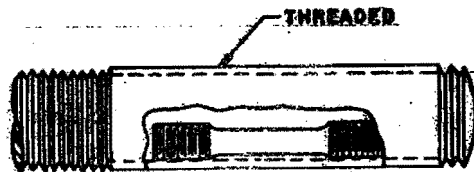


Figure 4 - Location of tension-test specimen when turned from large-size bolt studs (see 4.5.2.2.1.2).

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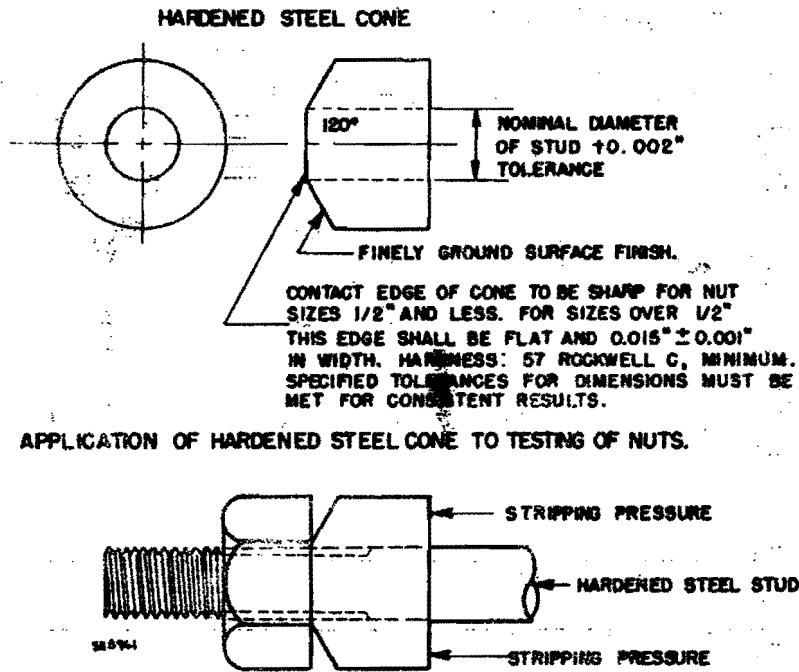


Figure 5 - Cone and assembly for cone stripping test.