SAE International™

SURFACE VEHICLE STANDARD

SAE J2271 JAN2009

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Superseding J2271 JUN2004

(R) Ship Systems and Equipment—Part Standard for Studs—Continuous and Double End (Inch Series)

RATIONALE

Configuration changes include:

- Added UNRF thread configurations for diameters 0.190 inch to 1-1/2 inches. Expanded the size (diameter) range of UNRC and 8UN studs.
- Added NC-5 HF and NC-5 CSF interference threads for use where a larger diameter is required for interference fit in an oversize tapped hole. Added ONF interference fit threads in Appendix B.
- The constant strength (undersize) stud body has been deleted in favor of the more commonly used reduced diameter body. Added Full Diameter Body configuration.
- The tap end thread length dimensions have been revised to minimize variations in thread length.
- Due to configuration changes, the Part Identification Number System has been revised and all part numbers are different from earlier revisions.
- Added Appendix A to provide guidance on the selection and installation of NC-5 Interference-Fit Tap End Studs.

Materials added and other material changes are:

- Titanium alloy 32 (Ti-5-1-1-1) to ASTM F 468.
- Ni-Cr-Mo-Cb (UNS N06625) to ASTM F 468 for high temperature and seawater applications.
- Ni-Cr-Mo-W alloy (UNS N06686) to ASTM F 468.
- Stainless steel B8 and B8M to ASTM A 193.
- Stainless steel 300 series per ASTM F 593 Group 1.
- Carbon Steel Grade B per ASTM A 307.
- Carbon and Alloy Steels - SAE J429 Grades 2, 5 and 8 (Grade 5 replaces ASTM A 449 Type 1 and Grade 8 replaces ASTM A 354 Grade BD for diameters of 1-1/2 inches and less).
- Added note comparing titanium materials and on material selection to minimize galling.
- The Part Identification Number Field for materials was expanded to two characters for all materials.

Changes in coating materials:

- MIL-L-46010 deleted for dry film coatings.
- Adding marking requirements for use of coated B7 material per ASTM A 193.
- Added Zinc/Aluminum Inorganic coatings per ASTM F 1136.
- Substituted ASTM F 1941 for ASTM B 633 and ASTM B 695 for zinc coating requirements.
- Identified recommended coatings for each stud material.
- Added a designator for coatings not covered by SAE J2271.

Changes in Quality Assurance requirements:

- Identified sampling levels for tests and inspections.
- Added ASTM F 788/F 788M and SAE J1061 as references for surface defects inspection.
- Changed primary inspection method for decarburization/carburization to ASTM F 2328
- Deleted several supplementary inspections for ASTM A 193 materials.

1. SCOPE

1.1 Purpose

This SAE Parts Standard provides dimensional and quality assurance requirements for studs in the following configurations in standard materials used for ship system applications:

a. Continuous thread studs in UNRC and 8UNR series in the following threads and diameters:
   - UNRC threads (0.190 through 4 inches)
   - UNRF threads (0.190 through 1-1/2 inches)
   - 8UNR threads (1-1/8 through 4 inches)

b. Double end studs (clamping type) where both ends are of the same thread length in the following threads and diameters:
   - UNRC threads (1/4 through 4 inches)
   - UNRF threads (1/4 through 1-1/2 inches)
   - 8UNR threads (1-1/8 through 4 inches)

c. Double end studs (tap end type) where the tap end thread length is equivalent to 1-1/2 nominal diameters:
   - NC-5 interference-fit tap end thread with UNRC, UNRF or 8UN nut end threads (1/4 through 1-1/2 inches)
   - UNRC and 8 UN threads both ends (1/4 through 4 inches)
   - UNRC threads both ends (1/4 through 1-1/2 inches)

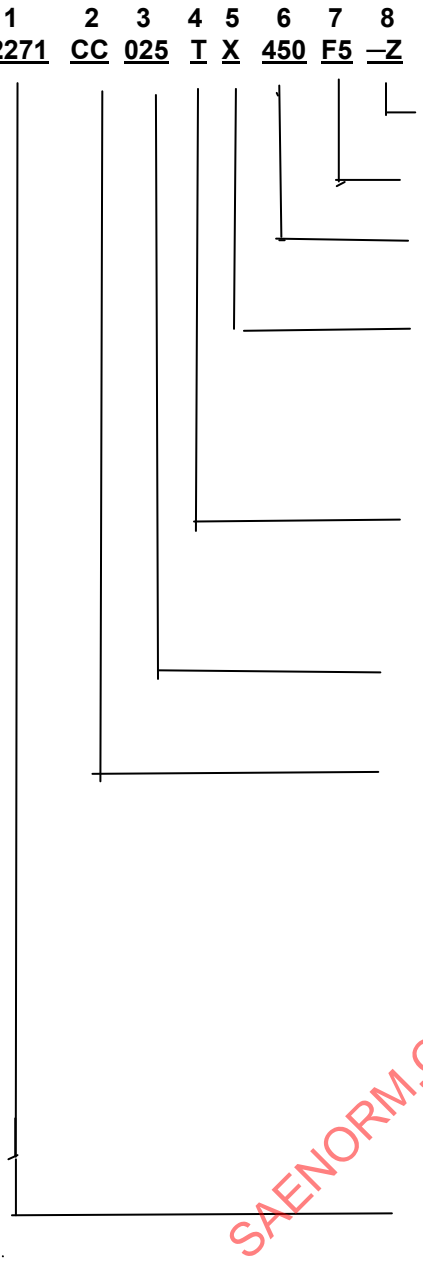
1.2 Field of Application

These studs are primarily for use in ship systems and equipment. The continuous thread studs and the reduced body diameter double end studs are configurations particularly suited to applications that are subject to high impact (H.I.) shock requirements.

1.3 Configurations and Part Identification Numbers

Figure 1 identifies the type and body configurations of the studs covered by the document. Figure 1 also provides a part numbering system with a unique part identification number for each stud. Table 1 is a listing of the materials covered by this standard. The part identification number identifies thread type, diameter, type of stud, body diameter, length of the stud, and material (including coating, where applicable). See 6.9 for change in Part Identification Numbers from the previous issue.

Part Numbering System for Studs



Field (Description)

Coating Designator (When applicable – See 4.10 for designators)

Material Designator – See Table 1 for material designations)

Length (3 digits in hundredths of an inch for lengths under 10 inches and 4 digits for longer lengths) See 4.4.2 for permitted length increments

Stud Body Configurations (See 4.2 and Table 5)
F – Double End Stud – Full Diameter Body (See 4.2.2)
R – Double End Stud – Reduced Diameter Body (See 4.2.1)
S – Double End Stud – (Body diameter Optional – See 6.9.2)
X – No body (continuous thread)

Stud Type
C – Double End Clamping Type (See 4.1.2, Table 3 and Figure 3)
D – Double End With Tap End (See 4.1.2. Table 4 and Figure 4)
T – Continuous Thread (See 4.1.1. Table 2 and Figure 2)

Nominal Diameter – 3 digits in hundredths of an inch
as shown in Table 2 (See Tables 2 through 5 as applicable)

Type Thread – First Letter (Nut End). Second Letter (Tap End or other Nut End) – Two letters required
1st and 2nd Letter Designators
C – UNRC (UNC) thread form (See 4.3.1)
F – UNRF (UNF) thread form (See 4.3.1)
U – 8UNR (8UN) thread form (See 4.3.1)
2nd Letter designators only
B – NC-5 CSF Interference Fit Thread (See 4.3.3)
H – NC-5 HF Interference Fit Thread (See 4.3.3)
N – NC-5 ONF (See Appendix B for requirements)
S – NC-5 HFS Interference Fit Thread (See 4.3.3)
See 4.3.3 for additional Navy Developed NC-5 Interference Fit Thread Designators for improved performance

SAE Document Number - J2271

The part number example shown above, J2271CC025TX450F5-Z is for a continuously threaded stud with 1/4-20 UNRC threads with a length of 4-1/2 inches manufactured of carbon steel per SAE J429 Grade 5 and zinc plated.

FIGURE 1 - PART IDENTIFICATION NUMBERS (PIN'S) FOR CONTINUOUS AND DOUBLE END STUDS (INCH SERIES)

TABLE 1 - MATERIALS

Fig 1 PIN – Field 7 Material Designator		Material Standard	Grade or Alloy	Diam. (Inches)	Marking	Tensile Strength ksi (min)[1]	Yield Strength (min ksi)[1]	Fig. 1 PIN – Field 8 Coatings[2] (When Applicable)
New	Old							
A1	A	ASTM A 193 Chrome-molybdenum-vanadium steel for high temperature	B16	2-1/2 and <	B16	125	105	None
				> 2-1/2	B16	110	95	
B7	B	ASTM A 193 Chrome-molybdenum steel for high temperature	B7	2-1/2 and <	B7	125	105	None
				> 2-1/2	B7	115	95	
		Same as above – temperature limited by coating (See 6.7)	B7	2-1/2 and <	B7 CTD	125	105	**–D, –V, –W, –X, –Y, –Z**
				> 2-1/2		115	95	
		Stainless Steel						
B8		ASTM A 193	B8 (304)	> 1-1/2	B8	75	30	None
C8		ASTM A 193	B8M (316)	> 1-1/2	B8M	75	30	None
CA		ASTM F 593 Stainless Steel Annealed	316 or 316L Group 2 Alloys	¼ to 1-1/2	F593B	75 – 100	30	**–D**
CW	C	ASTM F 593 Stainless Steel Cold Worked		< ¾ in	F593G	100-150	65	**–D**
				¾ to 1-1/2	F593H	85-140	45	
CS		ASTM F 593 Stainless Steel Strain Hardened		¼ to 5/8	F593E	120 - 160	95	**–D**
				¾ to 1	F593F	110 - 150	75	
				1-1/8, 1-1/4	F593G	100 - 140	60	
				1-3/8, 1-1/2	F593H	95 - 130	45	
HA		ASTM F 593 Stainless Steel Annealed	Group 1 Alloys 304, 304L, 18-9LW, 302HQ, 305 or 384 (Group 2 Alloys may be provided, See 6.6)	¼ to 1-1/2	F593B	75 - 100	30	**–D**
HW		ASTM F593 Stainless Steel Cold Worked		< ¾ in	F593C	100 - 150	65	**–D**
				¾ to 1-1/2	F593D	85 - 140	45	
HS		ASTM F593 Stainless Steel Strain Hardened		¼ to 5/8	F593A	120 - 180	95	**–D**
				¾ to 1	F593B	110 - 150	75	
				1-1/8, 1-1/4	F593C	100 - 140	60	
				1-3/8, 1-1/2	F593D	95 - 130	45	

TABLE 1 - MATERIALS (CONTINUED)

Fig 1 PIN – Field 7 Material Designator		Material Standard	Grade or Alloy	Diam. (Inches)	Marking	Tensile Strength ksi (min)[1]	Yield Strength (min ksi)[1]	Fig. 1 PIN – Field 8 Coatings[2] (When Applicable)
New	Old							
		Steel						
D8		SAE J429 (See 6.9.4)	Grade 8	¼ to1-1/2	6 radial lines @ 60°	150	130	**–D, –V, -W, –X, –Y,**
BD	D	ASTM A354 (See 6.9.4)	Grade BD	> 1-1/2 to 2-1/2	BD[4]	150	130	**–D, –V, -W, –X, –Y,**
				Over 2-1/2		140	115	
EA	E	ASTM A 307	Gr A or B	¼ to 4	307A or 307B	60 60 – 100	–	**–D, –V, –W, –X, –Y, –Z**
F2		SAE J429 (Caution: See 6.4)	Grade 2	¼ to ¾	None	74	57	
				7/8 – 1-1/2		60	36	
F5		SAE J 429 (See 6.9.3)	Grade 5	¼ to 1	3 radial lines @ 120°	120	92	**–D, –V, -W, –X, –Y, –Z**
				1-1/8 to 1-1/2		105	81	
F9	F	ASTM A 449 (See 6.9.3)	Type 1	1-5/8 to 3	A449[5]	90	58	
		Nickel Alloys						
AC		ASTM F 468 UNS 06625	Ni 625	¼ - 4	F468AC[3]	120	60	**–D**
BN		ASTM F 468 Ni-Cr-Mo-W Alloy 686 UNS 06686 Caution (See 6.5.1)	Grade 1	¼ to 4 in.	F468BN[3]	120 – 165	85	**–D**
CN			Grade 2		F468CN[3]	135 – 185	125	
DN			Grade 3		F468DN[3]	160 - 200	150	
EN			Grade 4		F468EN[3]	100 – 145	45	
KK	K	QQ-N-286 (See 4.6.1)	Ni-Cu-Al	< 1	●K●	130	90	**–D**
				1 to 4		130	85	
NC	N	ASTM F 468	Ni-Cu 400	¼ to ¾	F468U[3]	80 – 130	40	**–D**
				7/8 - 4		70 – 130	30	
		Titanium Alloys						
TF	T	ASTM F 468 (See 6.3 for comparison of titanium alloys)	Alloy 19	¼ - 1-1/2	F468FT	115 – 150	115	**–D**
TH			Ti 5-1-1-1	¼ - 4	F468HT[3]	105 – 150	90	**–D**

1. Stud mechanical properties are listed primarily for information and shall be in accordance with referenced product standards. Mechanical properties shall comply with this standard for sizes not listed in referenced product standards.
2. See 4.10 for coating requirements.
3. ASTM F 468 requirements normally apply to diameters 1/4 through 1-1/2 inches. However, the ASTM F 468 requirements and marking are being applied for diameters 0.190 through 4 inches for SAE J2271
4. May also be marked with 6 radial lines 60° apart if alloy steel meeting specific requirements.
5. May also be marked with 3 radial lines 120° apart if meeting SAE J429 Grade 5.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this publication to the extent specified herein. Unless otherwise specified, the latest issue of all publications shall apply.

NOTE: Contracts invoking this document may establish an effectivity date for referenced documents.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE AMS2487	Anodic Treatment of Titanium and Titanium Alloys Solution pH 12.4 Maximum
SAE AS1701	Lubricant, Solid Film
SAE J123	Surface Discontinuities on Bolts, Screws, and Studs in Fatigue Applications
SAE J429	Mechanical and Material requirements for Externally Threaded Fasteners
SAE J1061	Surface Discontinuities on General Application Bolts, Screws and Studs
SAEJ2270	Ship Systems and Equipment-Threaded Fasteners—Inspection, Test, and Installation Requirements

2.1.2 ASME Publications

Available from the American Society of Mechanical Engineers, 22 Law Drive, PO Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Forms)
ASME B1.3M	Screw Thread Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads (UN, UNR, UNJ, M and MJ)
ASME B1.12	Class 5 Interference-Fit Thread
ASME B18.18.1	Inspection and Quality Assurance for General Purpose Fasteners

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 193/A 193M	Alloy Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and other Special Service Applications
ASTM A 307	Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 354	Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners
ASTM A 380	Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A 449	Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 KSI Minimum Tensile Strength, General Use

ASTM A 967 Chemical Passivation Treatments for Stainless Steel Parts

ASTM F 468 Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

ASTM F 593 Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM F 788/F 788M Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

ASTM F 1136 Zinc/Aluminum Corrosion Protective Coatings for Fasteners

ASTM F 1470 Standard Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

ASTM F 1941 Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR)

ASTM F 2328 Standard Test Method for Determining Decarburization and Carburization In Hardened and Tempered Threaded Steel Bolts, Screws and Studs

ASTM G 98 Test Method for Galling Resistance of Materials

2.1.4 U.S. Government Publications

Available from Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, http://assist.daps.dla.mil/quicksearch/.

QQ-N-286 Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)

CID A-A-59004 Anti-Galling Compound, Thread Lubricating, Seizing Resistant, and Calcium Hydroxide Containing

3. DEFINITIONS

3.1 Body Bound Studs

Studs whose body is manufactured to specific tolerances to ensure a tight or interference fit with the equipment being secured. They may also be identified as finished, close body studs. Body bound studs are not covered by this document.

3.2 Reduced Diameter Body Studs

Studs whose body diameter may range from the minimum pitch diameter of the thread and does not exceed the minimum major thread diameter. The reduced diameter body studs replace the previously covered constant strength studs. (See 6.9.1.)

3.3 Double End Studs

Double end studs have threads on each end, typically with an unthreaded body in between.

3.3.1 Clamping Type

Has conventional threads on both ends and serves the function of clamping two bodies together with a nut on either end.

3.3.2 Interference Thread Type

Has conventional threads on the nut end and threads on the tap end that will give an interference fit in the hole in which it is installed.

3.4 Full Diameter Body Studs

Studs whose body diameter is within the dimensional limits of the major diameter of the thread.

3.5 Lot

A lot of fasteners shall consist of one heat of material, of one type and style, of the same nominal diameter, and fabricated and heat treated in the same batch or by a continuous process under the same conditions of time and temperature.

3.6 Nut End

The end or end(s) of the stud to be mated with a nut. (In some cases, double end clamping type studs that are designed for nuts on each end may be installed with the nut end acting as a set end.)

3.7 Part Identification Number (PIN)

A succinct format of data fields that identify a stud by the following: Type Thread, Nominal Diameter, Stud Type, Stud Body Configuration, Length, Material, and Coating

3.8 Set End

The end of the stud that is not for use with a nut but is threaded into a piece of material or component. The set end is often secured with an anaerobic compound or by interference fit threads (see tap end).

3.9 Stud Bolt (Standing Bolt)

A stud with threads on both ends or a continuous thread stud that is screwed permanently into a fixed part at one end and a nut on the other end.

3.10 Tap End

The end of the stud not intended for use with a nut. Particularly, an end with interference fit threads.

3.11 Total Thread

This dimension includes the complete or effective thread and all the incomplete thread. This length is determined by measuring the distance from the extreme end of the stud to the last scratch made by the run-out of the thread on the part.

4. TECHNICAL REQUIREMENTS

4.1 Configurations

4.1.1 Continuous Thread Studs

Studs that are continuously threaded over the entire length with a single thread configuration as shown in Figure 2. Dimensional requirements for continuous thread studs are shown in Table 2.

4.1.2 Double End Studs

This document defines the following types:

Type C—Double End Clamping Type Stud with equal thread lengths on each end (see Figure 3 and Table 3)
Type D—Double End Stud with shorter Tap End threads (see Figure 4 and Table 4)

4.2 Body Diameter Configurations and Dimensions

This document covers the following body diameter configurations and dimensions.

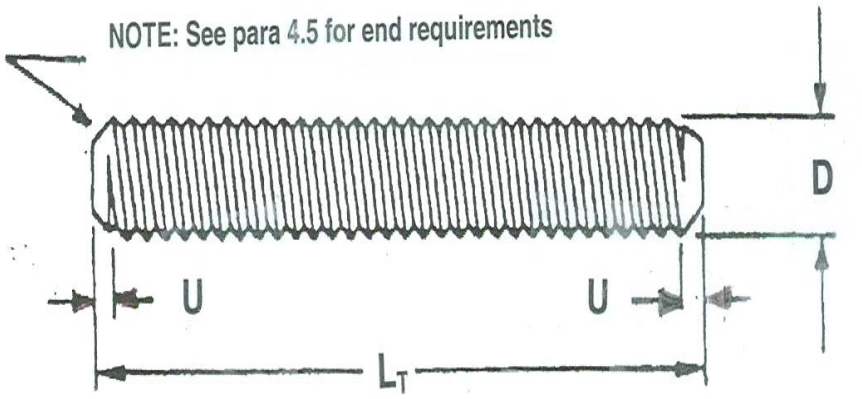
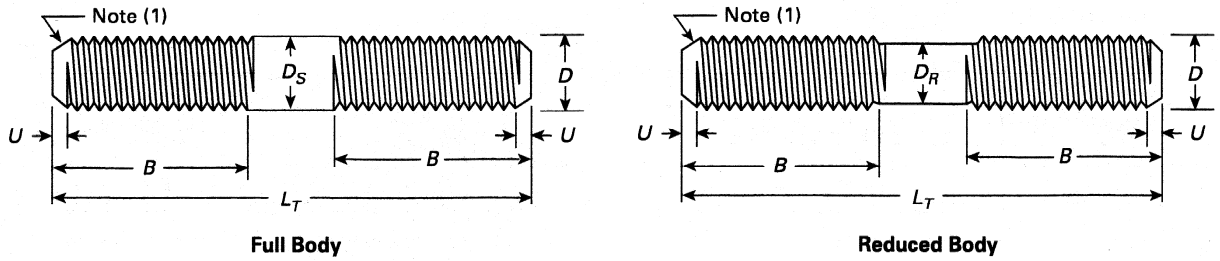


FIGURE 2 - CONTINUOUS THREAD STUD

TABLE 2 - DIMENSIONS[1] OF CONTINUOUS THREAD STUDS

Field 3 PIN	Nom. Size	Diam. (D)	Threads Per Inch			U_{max} = 2P		
			UNRC	UNRF	8UNR	(2P for UNRC threads)	(2P for UNRF threads)	(2P for 8UNR threads)
019	**#10**	**0.1900**	24	32	-	0.083	0.063	–
025	**¼**	**0.2500**	20	28	–	0.100	0.071	–
031	**5/16**	**0.3125**	18	24	–	0.111	0.083	–
038	**3/8**	**0.3750**	16	24	–	0.125	0.083	–
044	**7/16**	**0.4375**	14	20	–	0.143	0.100	–
050	**½**	**0.5000**	13	20	–	0.154	0.100	–
056	**9/16[2]**	**0.5625**	12	18	–	0.167	0.111	–
063	**5/8**	**0.6250**	11	18	–	0.182	0.111	–
075	**¾**	**0.7500**	10	16	–	0.200	0.125	–
088	**7/8**	**0.8750**	9	14	–	0.222	0.143	–
100	**1**	**1.0000**	8	12	–	0.250	0.167	–
113	**1-1/8**	**1.1250**	7	12	8	0.286	0.167	0.250
125	**1-1/4**	**1.2500**	7	12	8	0.286	0.167	0.250
138	**1-3/8**	**1.3750**	6	12	8	0.333	0.167	0.250
150	**1-1/2**	**1.5000**	6	12	8	0.333	0.167	0.250
163	**1-5/8**	**1.6250**	–	–	8	–	–	0.250
175	**1-3/4**	**1.7500**	5	–	8	0.400	–	0.250
188	**1-7/8**	**1.8750**	–	–	8	–	–	0.250
200	**2**	**2.0000**	4½	–	8	0.444	–	0.250
225	**2-1/4**	**2.2500**	4½	–	8	0.444	–	0.250
250	**2-1/2**	**2.5000**	4	–	8	0.500	–	0.250
275	**2-3/4**	**2.7500**	4	–	8	0.500	–	0.250
300	**3**	**3.0000**	4	–	8	0.500	–	0.250
325	**3-1/4**	**3.2500**	4	–	8	0.500	–	0.250
350	**3-1/2**	**3.5000**	4	–	8	0.500	–	0.250
375	**3-3/4**	**3.7500**	4	–	8	0.500	–	0.250
400	**4**	**4.0000**	4	–	8	0.500	–	0.250

1. See Table 7 for tolerances on stud lengths.
2. Non preferred size, not recommended for new design due to limited availability.



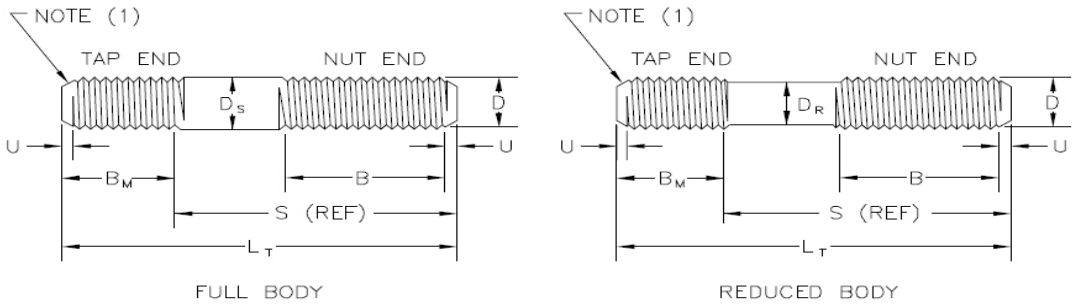
NOTE (1): See 4.5 for end requirements.

FIGURE 3 - DOUBLE END - CLAMPING TYPE STUD DIMENSIONS[1]

TABLE 3 - NUT END DIMENSIONS FOR CLAMPING TYPE STUDS

Nominal Size		Minimum Nut End Full Thread Length B			2 Thread Pitches (2P) U_{max} equals 2P		
Size	Diam. (D)	L ≤ 10	L > 10 and ≤ 16	L > 16	UNRC Threads	UNRF Threads	8UNR Threads
1/4	0.2500	0.750	1.000	1.500	0.100	0.071	–
5/16	0.3125	0.875	1.125	1.625	0.111	0.083	–
3/8	0.3750	1.000	1.250	1.750	0.125	0.083	–
7/16	0.4375	1.125	1.375	1.875	0.143	0.100	–
1/2	0.5000	1.250	1.500	2.000	0.154	0.100	–
9/16[2]	0.5625	1.375	1.625	2.125	0.167	0.111	–
5/8	0.6250	1.500	1.750	2.250	0.182	0.111	–
3/4	0.7500	1.750	2.000	2.500	0.200	0.125	–
7/8	0.8750	2.000	2.250	2.750	0.222	0.143	–
1	1.0000	2.250	2.500	3.000	0.250	0.167	–
1-1/8	1.1250	2.500	2.750	3.250	0.286	0.167	0.250
1-1/4	1.2500	2.750	3.000	3.500	0.286	0.167	0.250
1-3/8	1.3750	3.000	3.250	3.750	0.333	0.167	0.250
1-1/2	1.5000	3.250	3.500	4.000	0.333	0.167	0.250
1-5/8	1.6250	3.500	3.750	4.250	–	–	0.250
1-3/4	1.7500	3.750	4.000	4.500	0.400	–	0.250
1-7/8	1.8750	4.000	4.250	4.750	–	–	0.250
2	2.0000	4.250	4.500	5.000	0.444	–	0.250
2-1/4	2.2500	4.750	5.000	5.500	0.444	–	0.250
2-1/2	2.5000	5.250	5.500	6.000	0.500	–	0.250
2-3/4	2.7600	5.750	6.000	6.500	0.500	–	0.250
3	3.0000	–	6.500	7.000	0.500	–	0.250
3-1/4	3.2500	–	7.000	7.500	0.500	–	0.250
3-1/2	3.5000	–	7.500	8.000	0.500	–	0.250
3-3/4	3.7500	–	8.000	8.500	0.500	–	0.250
4	4.0000	–	8.500	9.000	0.500	–	0.250

1. See Table 5 for body diameters for full body or reduced body studs. See Table 7 for tolerances on overall stud lengths.
2. Non preferred size, not recommended for new design due to limited availability.



NOTE (1): See 4.5 for end requirements.

FIGURE 4 - TAP END STUD - FULL DIAMETER BODY AND REDUCED DIAMETER BODY DIMENSIONS[1]

TABLE 4 - DIMENSIONS (INCHES) FOR TAP END STUDS (1.5*D ENGAGEMENT*)

Size Diam	Tap End Full Thread Length B_M Nominal	Min	Max	U_{MAX} = 2P UNRC & NC-5 Thd	UNRF Thd	8UNR Thd	Minimum Nut End Full Thread Length[2] B L ≤ 10	L > 10 And ≤ 16	L > 16
¼	**0.375**	0.350	0.400	0.100	0.071	-	0.750	1.000	1.500
5/16	**0.469**	0.440	0.498	0.111	0.083	-	0.875	1.125	1.625
3/8	**0.563**	0.532	0.594	0.125	0.083	-	1.000	1.250	1.750
7/16	**0.656**	0.620	0.692	0.143	0.100	-	1.125	1.375	1.875
½	**0.750**	0.708	0.792	0.154	0.100	-	1.250	1.500	2.000
9/16[3]	**0.844**	0.802	0.896	0.167	0.111	-	1.375	1.625	2.125
5/8	**0.938**	0.892	0.983	0.182	0.111	-	1.500	1.750	2.250
¾	**1.125**	1.075	1.175	0.200	0.125	-	1.750	2.000	2.500
7/8	**1.313**	1.258	1.368	0.222	0.143	-	2.000	2.250	2.750
1	**1.500**	1.438	1.562	0.250	0.167	-	2.250	2.500	3.000
1-1/8	**1.688**	1.625	1.750	0.286	0.167	0.250	2.500	2.750	3.250
1-1/4	**1.875**	1.813	1.938	0.286	0.167	0.250	2.750	3.000	3.500
1-3/8	**2.063**	2.000	2.125	0.333	0.167	0.250	3.000	3.250	3.750
1-1/2	**2.250**	2.188	2.313	0.333	0.167	0.250	3.250	3.500	4.000
				UNRC					
1-5/8	**2.438**	2.375	2.500	-	-	0.250	3.500	3.750	4.250
1-3/4	**2.625**	2.563	2.688	0.400	-	0.250	3.750	4.000	4.500
1-7/8	**2.813**	2.750	2.875	-	-	0.250	4.000	4.250	4.750
2	**3.000**	2.925	3.075	0.444	-	0.250	4.250	4.500	5.000
2-1/4	**3.375**	3.300	3.450	0.444	-	0.250	4.750	5.000	5.500
2-1/2	**3.750**	3.675	3.825	0.500	-	0.250	5.250	5.500	6.000
2-3/4	**4.125**	4.050	4.200	0.500	-	0.250	5.750	6.000	6.500
3	**4.500**	4.425	4.575	0.500	-	0.250	-	6.500	7.000
3-1/4	**4.875**	4.775	4.975	0.500	-	0.250	-	7.000	7.500
3-1/2	**5.25**	5.150	5.350	0.500	-	0.250	-	7.500	8.000
3-3/4	**5.625**	5.525	5.725	0.500	-	0.250	-	8.000	8.500
4	**6.000**	5.900	6.100	0.500	-	0.250	-	8.500	9.000

1. See Table 5 for body diameters for full body or reduced body studs. See Table 7 for tolerances on overall stud lengths.
2. For short tap end studs where the minimum nut end thread length cannot be obtained see 4.4.1. The total thread length to the last scratch shall not exceed *B(min)* plus five thread pitches.
3. Non preferred size, not recommended for new design due to limited availability.

TABLE 5 - BODY DIMENSIONS FOR DOUBLE ENDED STUDS

See Figure 3 for Double End Clamping Studs and Figure 4 for Tap End Studs

Nom. Size	Nominal Dia. "D" and Max. Full Body[1] Dia. "D_S"	Minimum Body Diameter "D_S" for Full Body Studs[1,2] and Maximum Body Diameter "D_R" for Reduced Body Studs[1,2]			Minimum Body Diameter[1,2] "D_R" for Reduced Body Studs		
		UNRC & NC-5 HF Threads	UNRF Threads	8 UNR Threads	UNRC and NC-5 HF Threads	UNRF Threads	8 UNR Threads
¼	**0.2500**	0.241	0.243		0.213	0.223	
5/16	**0.3125**	0.303	0.304		0.271	0.281	
3/8	**0.3750**	0.364	0.367		0.329	0.343	
7/16	**0.4375**	0.426	0.428		0.385	0.400	
½	**0.5000**	0.488	0.491		0.444	0.462	
9/16[3]	**0.5625**	0.550	0.552		0.502	0.521	
5/8	**0.6250**	0.611	0.615		0.559	0.583	
¾	**0.7500**	0.735	0.739		0.677	0.703	
7/8	**0.8750**	0.859	0.863		0.795	0.822	
1	**1.0000**	0.983	0.987		0.910	0.938	
1-1/8	**1.1250**	1.106	1.112	1.108	1.023	1.063	1.035
1-1/4	**1.250**	1.231	1.237	1.233	1.148	1.188	1.160
1-3/8	**1.3750**	1.354	1.362	1.358	1.256	1.313	1.284
1-1/2	**1.5000**	1.479	1.487	1.483	1.381	1.438	1.409
1-5/8	**1.6250**	–		1.608	–		1.534
1-3/4	**1.7500**	1.727		1.733	1.609		1.659
1-7/8	**1.8750**	–		1.858	–		1.784
2	**2.0000**	1.975		1.983	1.843		1.909
2-1/4	**2.2500**	2.225		2.233	2.093		2.158
2-1/2	**2.5000**	2.473		2.483	2.324		2.408
2-3/4	**2.7500**	2.723		2.733	2.574		2.658
3	**3.0000**	2.973		2.982	2.824		2.908
3-1/4	**3.2500**	3.223		3.232	3.073		3.158
3-1/2	**3.5000**	3.473		3.482	3.323		3.407
3-3/4	**3.7500**	3.723		3.732	3.573		3.657
4	**4.0000**	3.973		3.982	3.823		3.907

1. Minimum and Maximum Body Dimensions apply before coating.
2. See 4.2.1, 4.2.2 and ASME B1.12 for body diameter dimensions for interference fit threads.
3. Non preferred size, not recommended for new design due to limited availability.

4.2.1 Reduced Diameter Body

The maximum body diameter is the minimum major diameter of the thread as defined in ASME B1.1 for Standard Series Threads (UN/UNR) and ASME B1.12 for NC-5 Interference fit threads. The minimum body diameter is the minimum pitch diameter of the thread as defined in ASME B1.1 for the thread with the smallest pitch diameter. The dimensions for reduced diameter bodies for the various standard thread series configurations are identified in Table 5.

4.2.2 Full Diameter Body

The maximum body diameter is the same as the nominal diameter of the fastener. The minimum body diameter is the minimum major diameter for the applicable threads as shown in the ASME B1.1 table titled “Limits of Size for Standard Series Threads (UN/UNR)” and in ASME B1.12 for NC-5 interference fit studs. If the two ends have different threads, the minimum body diameter will be based on the thread with smallest minimum major diameter. The dimensions for full diameter bodies for the various configurations (except interference fit configurations) are identified in Table 5.

NOTE: An S Designation is to be used when either a Full Diameter Body or Reduced Diameter Body can be provided at the supplier’s option. See Figure 1 and 6.9.2.

4.3 Type Thread

Except for interference fit tap ends, threads, when rolled, shall be controlled root radius Unified inch coarse, fine or 8 thread series (UNRC, UNRF, or 8UNR series), in accordance with ASME B1.1. Threads produced by other methods shall be Unified inch coarse, fine, or 8 thread series (UNC, UNF, or 8UN) in accordance with ASME B1.1. Unless otherwise specified below, uncoated and unplated threads shall conform to the maximum (GO) and minimum (NOT GO) limits of Class 2A. Coated and plated threads shall conform to the maximum limit of Class 3A (GO) and the minimum limit of Class 2A (NOT GO).

4.3.1 Continuously Threaded Studs

The thread configuration shall be as designated by the part number (See Figure 1). Selection of thread type for particular diameters shall be limited to the sizes identified in Table 2.

4.3.2 Tap End Threads (Standard Threads)

For non-interference fit tap end studs, the threads for the tap end configurations shall be as designated by the part number (See Figure 1). The threads on the tap end shall be Class 3A in accordance with ASME B1.1.whether coated or not coated. (See 4.10 for coating requirements) The thread length for the tap end threads shall be as specified in Table 4.

4.3.3 Tap End Threads (Interference-Fit)

Tap end threads shall be ASME B1.12 Class 5 interference fit threads selected from those listed Table 6 to fit the application. (See Appendix A for a more detailed description of these threads, their suggested usage and applicable internal threads for the tapped hole.) Dimensions and thread length shall as specified in Table 4.

NOTE: As used in this standard, the interference fit thread forms are from ASME B1.12. The minimum full thread lengths are the same but the total thread length is shorter due to the tighter tolerances in this standard.

4.4 Length

The overall length of the stud, measured parallel to the axis, is the distance from end to end. The tolerances on overall length shall be as tabulated in Table 7.

4.4.1 Short Studs

Double end clamping type studs that are too short to accommodate the standard length threads on each end are not covered by this standard. Instead, the selection of continuous thread studs is recommended. For short tap end studs where the minimum nut end thread length cannot be obtained the nut end shall be threaded the remaining length, except the nut end thread length shall be limited to provide a minimum of two thread pitches between the tap end threads and the nut end threads.

TABLE 6 - TAP END INTERFERENCE-FIT THREADS

PIN Thread Field 2nd Character	ASME B1.12 Standard Tap End Interference-Fit	PIN Thread Field 2nd Character	ASME B1.12 Appendix B or C Alternate Navy Developed Tap End-Interference-Fit	
B	NC-5 CSF	**D**	NC-5 CSFS	Appendix C
		L	NC-5 CSFK	Appendix C
H	NC-5 HF	**S**	NC-5 HFS	Appendix C
		K	NC-5 HFK	Appendix C
		M	NC-5 HFM	Appendix B
N	NC-5 ONF	NOTE: NC-5 ONF requires longer tap end, see SAE J2271 Appendix B.		

TABLE 7 - LENGTH TOLERANCES FOR ALL TYPES OF STUDS

Nominal Length(1) (Inches)		**Length Tolerances (Inches)**	
Over	**Thru**	**Tap End Studs**	**Clamping and Continuous Thread Studs**
½	**2-1/2**	± 0.03	± 0.04
2-1/2	**4**	± 0.05	± 0.08
4	**8**	± 0.08	± 0.10
8	**16**	± 0.10	± 0.12
16		± 0.12	± 0.18

1. Nominal Length is (L_T) Overall Length for all types of studs.

4.4.2 Length Increments

Stud lengths shall be in whole inches and one-quarter inch increments for lengths up to 10 inches. For stud lengths greater than 10 inches, lengths shall be in whole inches and one-half inch increments. (See Note 6.11 for non-standard lengths.)

4.5 Finish of Stud Ends (Points)

The ends of studs shall be reasonably square with the axis of the screw and the slight rim or cup resulting from roll-threading shall be permissible. The ends of the stud shall be chamfered or rounded from a diameter slightly less than the thread root diameter to produce a length of point or incomplete thread within the limits for U_{max}. U_{max} is equal to two thread pitches and for referee purposes is defined as the distance the point enters into a cylindrical NOT GO major diameter ring gage. When chamfered, the angle shall be 45 ± 5 degrees. At the manufacturer's option, the end of the screw may have a rounded point of radius equal to approximately 1.4 times the major thread diameter

4.6 Material

Materials shall be selected from one of those listed in Table 1 and shall be designated in the part identification number (see 4.9) with the two character designation from Table 1. Material shall be in accordance with the applicable standard current at the time of ordering unless otherwise approved by the purchaser.

4.6.1 Special Requirements for Nickel-Copper-Aluminum Material

The finished Nickel-Copper-Aluminum studs shall have the following properties:

Material	QQ-N-286, UNS – N05500, Annealed and Age Hardened
Tensile Strength	0.250 – 4.000 Diameter – 130 000 – 180 000 psi
Yield Strength	0.250 – 0.875 Diameter – 90 000 psi min.
	1.000 – 4.000 Diameter – 85 000 psi min.
Elongation	20% min in 4 Diameters (Test specimen)

Nickel-Copper-Aluminum material that has been roll threaded shall be re-solution annealed and age hardened after the roll threading process. Material that has been cut threaded or single tool threaded can be produced from annealed and age hardened bar with no further heat treatment. Stud testing shall be in accordance with ASTM F 468 with mechanical properties as noted above.

4.6.2 Passivation

All corrosion resistant steel fasteners shall be cleaned and passivated. Passivation shall be as identified in the applicable material standard. If not defined in the applicable material standard, passivation shall be the chemical treatment of the stainless steel with a mild oxidant, such as a nitric acid solution in accordance with ASTM A 380 or ASTM A 967. Unless specified by the purchaser, the chemical treatment applied shall be selected by the manufacturer from among the listed passivation treatments. Similarly, unless otherwise specified by the purchaser, the manufacturer shall select the test used for detection of free iron and other anodic surface contaminants

4.7 Identification Marking

Marking shall be in accordance with the product marking requirements of the applicable material standard as identified in Table 1. For tap end studs, material identification shall be on the nut end of the stud. For studs with interference-fit tap end threads, the tap end shall be marked to identify the interference-fit thread configuration unless this marking is waived by the purchaser. The NC-5 thread configurations are identified in Table 6. For small diameter studs with insufficient space for marking the “NC-5” prefix of the thread identity is not required.

4.7.1 Marking Location

The material symbol, manufacturer’s symbol, and lot number (if required) shall be marked on each stud ¼ inch diameter and larger. The marking shall be applied to one or both nut ends of Double End Studs (Clamping type) and Continuous Thread Studs. If all of the marking cannot be applied due to space limitations, the marking shall be applied using the following order of precedence: material symbol, manufacturer’s symbol, and lot number.

4.8 Thread Length

4.8.1 Threads for Continuously Threaded Studs

Continuously threaded studs shall be threaded the full length with dimensions per Table 2.

4.8.2 Nut End Thread Length (Double End Studs and Tap End Studs)

The minimum full nut end thread length, B, is identified in the applicable tables. The full thread length B is the distance, measured parallel to the axis of the stud, from the extreme applicable nut end of the stud to the gage face opposite that end of a non-chamfered Class 3A GO ring gage where the gage stops when installed as far as the thread permits. The total thread length shall not exceed the minimum full thread length plus five thread pitches and is determined by measuring the distance from the extreme end of the stud to the last scratch made by the run-out of the thread on the part.

4.8.3 Tap End Thread Length

The tap end full thread length, B_M, has both a small maximum and minimum tolerance as specified in Table 4.

4.8.3.1 Measuring Tap End Thread Length on Non Interference Fit Tap End Studs

The full tap end thread length, B_M, is determined by measuring from the extreme tap end of the stud to the gage face opposite that end of a non-chamfered Class 3A GO ring gage where the gage stops.

4.8.3.2 Measuring Tap End Thread Length on Interference Fit Tap End Studs.

The full tap end thread length, B_M, is determined by measuring from the extreme tap end of the stud to the gage face opposite that end of a non-chamfered GO ring gage (for the applicable Class of NC-5 thread) where the gage stops.

4.9 Part Identification Number

To avoid possible misunderstandings when specifying these studs and to comply with Department of Defense requirements for part identification, studs shall be identified with a part identification number. Part identification numbers shall be limited to those permitted by Figure 1 applying the requirements of this document. The part identification numbers, Figure 1, were changed in the 2008 revision. See 6.9 and 6.10 for a discussion of the changes.

4.10 Coatings

After coating, stud threads shall not exceed Class 3A maximum size requirements. For coated studs the following designators (a letter preceded by a dash (—) shall be added to the last Field of the Part Identification Number (PIN) in Figure 1. If interference fit studs are to be coated, only the "**–S**" designator is to be used and the purchaser must identify the coating requirements, where the coating is to be applied and the dimensions that apply after coating. No designator is used in the PIN to identify uncoated studs.

D = Dry Film Lubricant (see 4.10.1)
S = Special Coating requirements are to be identified by the purchaser (see above)
V = Pigmented Zinc/Aluminum Coating – No Chromium Permitted – 500 hr SST (see 4.10.3 and 4.10.4)
W = Pigmented Zinc/Aluminum Coating – Chromium Permitted – 500 hr SST (see 4.10.4)
X = Zinc/Aluminum Inorganic Coating – No Chromium Permitted – 720 hr SST (see 4.10.3)
Y = Zinc/Aluminum Inorganic Coating – Chromium Permitted – 1000 hr SST (see 4.10.3)
Z = Electro-deposited Zinc (see 4.10.2)
SST is Salt Spray Test as identified in ASTM F 1136

4.10.1 Dry Film Lubricant

The suffix "**–D"** indicates the dry film lubricant is to be in accordance with an SAE AS1701 Class I suitable for temperatures to 450 °F (232 °C). If a dry film lubricant suitable for a higher temperature is required, use the designator "**-S**" and specify a dry film lubricant compatible with the higher temperature. (SAE AS1701 has dry film lubricants suitable for temperatures to 850 °F (454 °C).

4.10.2 Zinc Coatings

Zinc electro-deposited coatings shall be in accordance with ASTM F 1941 as identified herein. Coating thickness is applicable to significant surfaces only. Significant surfaces are considered to be the stud ends and the unthreaded stud body. The following minimum plating thickness is required:

1-3/8 diameter or less – ASTM F 1941 Thickness Designation 5 (0.0002) or 1/6 the allowance as identified in ASME B1.1, whichever is less.
1-1/2 diameter and greater– ASTM F 1941 Thickness Designation 8 (0.0003).

NOTE: Per the above requirements, some ¼ and 3/8 diameter studs will have coatings less than 0.0002 inches.

Unless otherwise designated by the purchaser, Designation A (Clear) chromate finish shall be provided.

4.10.3 Zinc/Aluminum or Chromium Zinc Inorganic Coatings

These coatings shall meet the requirements of Grade 3 in accordance with ASTM F 1136 except that a pigmented topcoat is permitted. The basecoat shall have a minimum thickness of 5.5 µm. (If a particular pigmented topcoat color is required, see 4.10.4 for guidance.) For designator "Y", coatings with or without chromium may be furnished at supplier's option provided the salt spray test requirements identified in 4.10 are met. When specified in the purchase order, the applicator shall certify the process did not expose the parts to acid or phosphating to guarantee the absence of internal hydrogen embrittlement.

NOTE: Some 3/8-inch and smaller diameter studs may require undersized threads to meet the ASTM F 1136 F Grade 3 coating thickness requirements for clear sealer. If a pigmented topcoat is specified, larger diameter studs may also require undersized threads.

4.10.4 Pigmented Topcoats

If a pigmented topcoat of a particular color is required it must be specified in the ordering documentation.

4.10.5 Coatings for Titanium Studs

All studs of titanium alloy shall be anodized in accordance with SAE AMS2487 (except testing requirements may be negotiated between manufacturer and coating supplier). No suffix designator is used to identify the anodizing. In addition, the purchaser should specify a dry film lubricant unless an uncoated stud is specifically needed to allow another coating or an anti-galling compound to be applied by the user.

NOTE: See 4.10.1 for dry film lubricants and 6.8.1 for guidance on anti-galling and lubricant coatings for titanium.

5. QUALITY ASSURANCE REQUIREMENTS

5.1 General Requirements

5.1.1 Unless otherwise specified in the ordering documentation, inspection and testing for mechanical properties, physical properties, and other quality requirements shall be as specified in the applicable material and product standards. When specified by the purchaser or required by the product standard, the supplier shall provide certification documenting the performance of all mandatory tests and inspections. Where the applicable material specification is silent regarding the number of samples to be tested, sampling shall be in accordance with ASTM F 1470.

5.1.2 Unless otherwise specified by the purchaser, inspection and sampling for dimensions and thread fit shall be in accordance with the following:

a. Acceptability of non-interference fit screw threads shall be determined based on System 21 or System 22 of ASME B1.3M, at manufacturer's option. System 21 shall be the referee method in case of dispute. For interference fit thread gauging, the manufacturer shall select a system as identified in ASME B1.12 unless the purchaser invokes specific inspection requirements.

CAUTION: Where there are assembly and performance concerns, system 21 alone may not be suitable as it does not provide minimum material size control. In such cases, the purchaser may specify additional requirements.

b. Dimensional and nondestructive inspections and minimum sample size shall be in accordance with the inspection levels specified in 5.2.

5.1.3 Should a dimension be determined to have a variance, it shall be deemed conforming to this document if the purchaser, who is the installer, accepts the variance based on fit, form, and function.

5.1.4 Surface Discontinuity Inspection

Surface discontinuity inspection shall be conducted on the applicable fasteners as specified below:

a. Surface discontinuity inspection shall be conducted when required by the applicable product standard as identified in Table 1.

b. Sample size for visual inspection shall be in accordance with the applicable surface discontinuities inspection standard unless another sample size is specified by the purchaser.

c. If the product standard does not require a surface discontinuity inspection, no inspection is required unless specified by the purchaser. The purchaser shall specify any applicable limits in the original inquiry and purchase order.

NOTE: The following are suggestions of how discontinuity inspections may be specified by the purchaser:

1. For studs to ASTM product standards whose minimum tensile strength is 90 000 psi or greater, surface discontinuity inspection shall be in accordance with ASTM F 788/F 788M.

2. For studs to SAE J429 with diameters through 1 inch inclusive whose length does not exceed 6 inches and whose minimum tensile strength is 90 000 psi or greater, surface discontinuity inspection shall be in accordance with SAE J1061 or SAE J123. For studs to SAE J429 with diameters greater than 1 inch or lengths greater than 6 inches whose minimum tensile strength is 90 000 psi or greater, surface discontinuity inspection shall be in accordance with SAE J123.

5.1.5 Disposition or reinspection of non-conforming lots shall be in accordance with ASTM F 1470 and for reinspection the sample size shall not be less than 150% of the sample size required for initial inspection.

5.2 Dimensional and Nondestructive Inspections

Each lot shall be subject to an inspection in which the following dimensions and nondestructive characteristics are inspected when applicable:

a. Body Diameter – ASTM F 1470 – Level B

b. Length – ASTM F 1470 Level B

c. Point diameter/dimensions – ASTM F 1470 Level B

d. Thread acceptability – ASTM F 1470 Level B

e. Thread length (verification that full thread lengths are in compliance with requirements) ASTM F 1470 Level B

f. Visual Inspection (including marking) ASTM F 1470 Level A

g. Surface discontinuity inspection in accordance with 5.1.4.

h. Should a purchaser note a dimensional variance from the requirements after purchase the Inspection Process for Lot Compliance After Shipment of ASME B18.18.1 shall apply in determining lot acceptability with the following modifications:

1. For designated characteristics the inspection level and sample size shall be as noted above.

2. For non-designated characteristics the process and Inspection Level identified in ASME B18.18.1 shall apply but the sample size shall be based on the sample size identified in ASTM F 1470 for the corresponding B18.18.1 inspection level.

5.3 Tests for Mechanical and Physical Requirements

As a minimum each lot of studs shall be subjected to the following tests when test procedures and requirements are identified in the applicable material specification.. For lots with stud lengths too short for tensile or yield testing, a minimum of two samples are required for hardness testing. When the number of samples to be tested is not identified in the applicable material specification the number of samples shall not be less than specified in ASTM F 1470 for Sample Size C and the lot shall be rejected if at least one nonconforming part is identified in the random sample.

a. Yield strength or proof load (See Note)

b. Tensile strength (See Note)

c. Hardness

d. Hydrogen embrittlement (Generally applicable to plated studs)

NOTE: The noted tests are not required for studs machined from bar or cut from threaded rod by the user when the material conforms to the mechanical and chemical properties of the applicable product standard before fabrication and no cold work or additional heat treatment is performed.

5.4 Supplementary Test and Inspections

The following test and inspections shall be applied when the stud is manufactured of the applicable material.

5.4.1 Hardened and Tempered Carbon or Alloy Steel Studs

Hardened and Tempered Steel Studs shall be inspected for decarburization and carburization in accordance with ASTM F 2328 except where the applicable product standard lists the process, dimensions and microindentation data to be used. Sample size shall be in accordance with ASTM F 1470 Level C. For studs manufactured by the user from bar stock subject to similar inspection requirements, additional testing is not required.

6. NOTES

(Section 6 contains information of a general or explanatory nature which may be helpful but which is not a requirement.)

6.1 Test Reports

The procurement document should specify whether or not test reports are required. It is recommended that certified reports documenting the mandatory tests of the material specification and any other pertinent tests be required for each lot procured.

6.2 Installation of Studs

Several methods are often used to prevent rotation of studs after installation. The most common method is to install the stud with an anaerobic thread-locking compound. SAE J2270 identifies some of these compounds along with installation and test procedures. For high temperature applications where a suitable thread-locking compound cannot be used, an interference-fit tap end stud may be selected. SAE J2271 covers several configurations of interference-fit tap end stud with a thread length of 1.5 diameters. Appendix A describes these configurations and provides some guidance on their selection and installation. Appendix B covers ONF interference-fit studs with a tap end thread length of 2.75 diameters.

6.2.1 Studs with UNRF Threads

In the shipbuilding industry, coarse threads are generally preferred to fine threads. However, there may be applications in which fine threads are preferred. Also the addition of Fine thread studs to SAE J2271 permits this standard to be used for logistic support of existing applications in which fine threads have been used.

6.2.2 Interference-Fit Tap End Studs

Appendix A provides information and sources for guidance on installation of tap end interference-fit studs.

6.2.3 Studs with Different Tap End Lengths

This standard only covers tap end studs with a tap end length of 1-1/2 diameters. This length is suitable for nearly all applications. However, longer tap end lengths may be necessary when installing high strength studs into tapped holes in some lower strength ferrous materials and possibly shorter tap ends will be required in some cases. In such cases the user will need to develop requirements for the tap end stud. In such cases, this standard can be used as a guide. Normally, all the user will have to do is specify a tap length in diameters of the stud and adjust the tap end dimensions to accommodate the change in length. For example: On a one-inch diameter stud for a tap end length of 2 diameters, the tap end length will increase in length by one-half inch. Therefore, the tap end thread length, B_M, would increase by exactly 0.500 inches. This applies for both standard and interference-fit tap end studs. ONF interference fit studs with a tap end length of 2.75 diameters are covered in Appendix B.

6.3 Comparison of ASTM F 468 Titanium Materials

Alloy 32 (Ti--5-1-1-1) is a near alpha titanium alloy of intermediate strength with high toughness, good weldability, stress corrosion cracking resistance, and room temperature creep resistance. It is well suited for marine environments where toughness and corrosion resistance are necessary. Titanium Alloy 23 (Ti-6Al-4V ELI) and Alloy 19 (Ti-38-6-44) have higher tensile and yield strengths than Alloy 32 (Ti-5-1-1-1). The dynamic toughness (a measure of the load and plastic energy dissipation necessary for crack initiation and propagation) of the Ti-5-1-1-1 alloy is nearly three times that of Ti-6Al-4V ELI and approximately an order of magnitude greater than Ti-38-6-44.

NOTE: Availability of this material may be limited.

6.4 SAE J429 Grade 2

The use of SAE J429 low carbon Grade 2 steel is not recommended for new design for several reasons. The lack of identification marking and low strength are the primary reasons to avoid using this material. For diameters over ¾ inch, SAE J429 Grade 2 requirements are basically equivalent to ASTM A 307 Grades A and B that are more generally available and for which grade markings apply. For interference-fit tap end studs the low mechanical properties may result in failure during installation unless the standard ASME B1.12 thread dimensions are modified.

6.5 Material Availability

Studs of most of the materials identified in this standard are not available off-the-shelf. Manufacturers do stock unthreaded bar and have the capability to manufacture studs in many materials with relatively short lead times. Many manufacturers also stock threaded rod that can be cut to length and shipped in short order. Materials most likely to be stocked include ASTM A 193 materials (particularly B7 and to a lesser extent B16), Stainless Steel 316 and 304, Ni-Cu Alloy 400, Carbon Steel (with and without zinc plating). The ASME A 193 B7 material has similar mechanical properties to SAE J429 Grade 5 and ASTM A 449 Type 1 but is more readily available.

6.5.1 Availability of Nickel Alloy 686

Users are cautioned to check on availability of Nickel Alloy 686 prior to specifying in designs due to limited availability.

6.6 Corrosion Resistant Steel (CRES) Alloys 316 and 316L

CRES Alloys 316 and 316L offer improved corrosion resistance over CRES Alloys 302HQ, 304, 304L, 305, 384, XM7 and 18-9LW. CRES 316 and 316L are preferred in applications that may come in contact with battery acid, seawater or exposed to salt atmosphere. CRES 316 and 316L are suitable replacements in applications specifying CRES Alloys 302HQ, 304, 304L, 305, 384, XM7 and 18-9LW.

It is recommended that the following note be added to drawings:

Fastener part numbers (PIN's) for Group 2 (316 and 316L) alloys may be used in lieu of similar part numbers for the less corrosion resistant Group 1 (300 Series CRES) alloys.

6.7 ASTM A193 Grade B7 Material with Coatings

B7 material is intended for high temperature applications for which coatings are not suitable. For example, zinc coating on male fasteners is not recommended for use in applications above 300 °F. A special marking, "CTD", as identified in Table 1 is to be added when studs of B7 material are coated.

6.8 Galling

Galling is a form of adhesive wear that can occur in fasteners as they are tightened. Galling is most prevalent in fasteners made from corrosion resistant materials that self-generate a protective oxide surface film [such as stainless steel, aluminum, titanium, and nickel based alloys]. As contact pressure increases on the sliding surfaces of the threads during tightening, the oxide layer is stripped off high points on the mating surfaces and the bare unprotected surfaces 'cold weld' together. As the fastener tightening continues, these localized cold welded joints shear, tearing off metal particles. Debris from the stripped oxide film and particles from the sheared joints are entrained in the sliding surfaces that exacerbates the adhesive wear. The process can ultimately lead to seizing of the fasteners and breakage, if tightening continues. Seizing can even occur during the loosening process. Galling is most prevalent when the external and internal thread materials have similar hardness values.

Galling is best avoided by: (1) selecting different alloys with different hardness values, or different strengths of the same alloy, thereby providing different hardness values, in the threaded joint; (2) providing lubrication, either solid film or anti-galling compound, to the threads prior to assembly (see SAE J2270 for additional information); and/or (3) slowing the tightening process since increased speed generates greater heat from friction and heat accelerates the 'cold weld' process.

When design considerations dictate the use of materials for which there is no experience, an evaluation of the material couple's resistance to galling should be made to reduce the risk of failures during installation. ASTM G 98 provides a test method for evaluating the galling resistance and yields a threshold galling stress. This threshold can then be compared to analytically determined contact pressures of the threaded joint during tightening to provide an assessment of the fastener design.

6.8.1 Methods to Prevent Galling of Titanium Studs

It is strongly recommended that a dry film lubricant or anti-galling compound be applied to titanium studs to prevent galling. This can be done by ordering the studs with a dry film lubricant applied (see 4.10) or by the installing activity applying an anti-galling compound or dry film lubricant. Dry film lubricants in accordance with SAE AS1701 Class I are suitable for temperatures below 232 °C (450 °F). For higher temperature applications the user should utilize a dry film lubricant from SAE AS1701 with a temperature rating suitable for the application. For Navy applications an anti-galling compound per CID A-A-59004 is often specified. For anti-galling compounds and dry film lubricants other than Class I per SAE AS1701, the installing activity must identify the coating to be used and the process for its application on drawings.

6.9 Part Identification Number Changes in the 2008Revision

The Field for the thread designator has been changed from one character to two characters so that the threads on both ends of the stud can be identified. The first character is either a C (Coarse) F (Fine) or U (8UN) to designate the primary nut end thread. The second character represents the thread on the tap end or secondary nut end. If the threads are the same on both ends, then the second character is the same as the first character. In the previous version, the Stud Type and Body Configuration Field covered both the body diameter and type of tap end thread. This Field now designates Body Type and is limited to T for Continuous Threads, F for Full Body, R for Reduced Body and S where either a Full or Reduced Diameter body can be provided at the supplier's option. The material designator has been changed from one character to two characters. Both the old and new material designations are shown in Table 1 - Materials. A coating designator field has been added and the first character of the designator is a "—" followed by a letter designating the coating.

6.9.1 Deleted Configurations and Their Designators

The following stud types and bodies are no longer covered. For dimensional requirements see the 2004 or earlier issue.

U – Double End Stud Bolt – Undersize (Constant Strength) (See Notes 1 and 2 below)
V – Double End Stud Bolt – Full or Undersize body (Notes 2 and 3 below)
X – Double End Stud – Tap End Interference Fit (NC-5 HFS Threads) Undersize Body (Notes 1 and 2)
Y – Double End Stud – Tap end Interference Fit (NC-5 HFS Threads) Full or Undersize Body (Notes 2 and 3)

NOTE 1: The current Reduced Diameter Body "R" has essentially the same minimum body diameter as the old undersized diameter body. However, the maximum body diameter may be slightly larger.

NOTE 2: Thread lengths and tolerances may be slightly different on the studs now covered.

NOTE 3: Similar Full or Reduced Body Studs are now covered. See 4.2

The previously covered Undersized body studs (designated "U" for clamping studs and "Y" for tap end studs with a NC-5 HFS tap end types) are no longer covered. However, the Reduced Diameter Bodies now covered have the same minimum diameter but a larger maximum diameter than that permitted for the old undersize diameter body.

6.9.2 Designators for Optional Body Types

Previously the "V" and "Y" body type designations permitted any body diameter from the constant strength (undersize) body to the full body. The "S" designator is now used when it is acceptable for the supplier to provide either a reduced body "R" or full body "F" at his option. This option can reduce lead-time, cost or both.

6.9.3 ASTM A 449 Type 1 and SAE J429 Grade 5

These two material Grades are considered equivalent. Prior to the 2008 Revision, only ASTM A 449 Type 1 was listed for all sizes. However for diameters through 1-1/2 inches the SAE J429 Grade 5 material is usually more readily available. To prevent duplication of part numbers for equivalent materials, SAE J429 Grade 5 is used for diameters through 1-1/2 inches and ASTM A 449 is used for larger diameters.

6.9.4 ASTM A 354 Grade BD and SAE J429 Grade 8

These two material Grades are considered equivalent. Prior to the 2008 Revision, only ASTM A 354 Grade BD was listed for all sizes. However for diameters through 1-1/2 inches the SAE J429 Grade 8 material is usually more readily available. To prevent duplication of part numbers for equivalent materials, SAE J429 Grade 8 is used for diameters through 1-1/2 inches and ASTM A 354 Grade BD is used for larger diameters.

6.10 Dimensions of Studs Made to Earlier Revisions

Except for continuous thread studs, there have been some changes in dimensions for studs to the 2008 revision. It is not expected that these dimensional changes will pose a problem if studs to the new part numbers are substituted for similar, earlier part numbers. To review earlier dimensions, one must use a SAE J2271 issue dated prior to 2008.

6.11 Non-standard Lengths for Studs

Field 6 of the part numbering system in Figure 1 can be used to create PINs to identify studs of non-standard lengths when necessary but these lengths are not recommended for new design as they do not support standardization and are not likely to be stocked.

6.12 Marginal Indicia

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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APPENDIX A - INFORMATION ON NC-5 INTERFERENCE FIT THREADS

A.1 PURPOSE

The purpose of this Appendix is to provide information about various NC-5 interference fit threads as defined in ASME B1.12 and general information that may be helpful in the selection and installation of interference fit studs.

A.2 ASME B1.12 NC-5 INTERFERENCE FIT THREADS

The Interference Fit Threads (both external and internal) are defined in ASME B1.12 and designated by prefix NC-5. The NC-5 prefix is followed by a suffix that indicates the type of material in which it is expected the thread will be installed. For external threads, these suffixes are:

HF – External thread for use in Hard Ferrous material with Brinell Hardness over 160 HB
CSF – External thread for use in Copper alloys and Soft Ferrous material with Brinell Hardness of 160 HB or less
ONF – External thread for use in Non-Ferrous material Other than Copper Alloys, any hardness

The diameters of the CSF and ONF threads are the same and larger than the diameters of HF threads. The length of engagement for ONF threads is 2.75 diameters and tap end thread lengths for this configuration are specified in Appendix B.

For internal threads, the suffixes are:

IF – Internal Thread for Ferrous material
INF – Internal Thread for Non-Ferrous material

Portsmouth Naval Shipyard (NSY) and others have found that the standard ASME B1.12 dimensions for the above threads often do not result in satisfactory installations. A major factor is believed to be that the recommendations are too general and the number of materials in use has expanded significantly since ASME B1.12 was developed. Some non-ferrous materials are relatively hard and when using these materials the interference is excessive. This is particularly the case for ONF threads that have twice the engagement of the HF and CSF threads. Portsmouth NSY conducted a research study in which interference fit threads were tested with many of the materials used in marine applications. The results of this study are summarized in Appendices B, C and D of ASME B1.12.

A.2.1 ASME B1.12 Appendices A, B, C and D

Additional external and internal threads are identified in the Appendices A through D of ASME B1.12 for information only and are not considered a part of B1.12 and in some cases may result in improved performance as identified later. Appendix A is an obsolete tentative standard not to be used for new design. Appendices B and C are the result of a research study by Portsmouth NSY on interference fits in a wide variety of metals and will be discussed later in more detail. Appendix D compares the percentage of Interference Metal for the standard NC-5 assemblies with those for assemblies identified in Appendices B and C.

A.2.1.1 ASME B1.12 Appendix B – Specifications for Elastic Interference-Fit Thread

The information in this Appendix is based on Portsmouth NSY research but the Fastener SC of the SAE Ship Systems Technical Committee has been unable to find a copy of the research report. The following thread forms are covered:

HFM – External thread for Hard Ferrous Material (Also Ni-Cu and Ni-Cu-AL)
IFM – Internal thread for Ni-Cu, Ni-Cu-Al and Entire Ferrous Material Hardness Range