UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ATTACHMENT 4

DOCKETED

BEFORE THE NUCLEAR REGULATORY COMMISSION

'84 NOV -1 P5:13

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	Docket Nos. 50-275 50-323 Construction Quality Assurance, Licensee Character and Competence

AFFIDAVIT OF STEVEN LOCKERT

STATE OF CALIFORNIA)
) ss.
COUNTY OF SAN LUIS OBISPO)

My name is Steven Lockert and I am writing this affidavit in my own words without threat or inducement from anyone. The purpose of this statement is to inform the USNRC, court authorities, and public that officials of Pullman Power Products Corporation (Pullman) and Pacific Gas & Electric Company (PG&E) have made false statements. False statements before the Atomic Safety and Licensing Appeals Board (ASLB) and false statements before the Region V staff of the USNRC.

The subjects of this discussion will be welded studs, quality control inspector training, and quality control inspector harassment and retaliation. The documents that contain false statements are: Diablo Canyon Letter (DCL) 84-067 dated 2/17/84, DCL-84-078 dated 2/29/84, DCL-84-195 dated 5/29/84, DCL-84-239 dated 6/26/84, DCL-84-243 dated 6/29/84, Affidavit of

C. M. Neary, Pullman's Quality Engineering Group Welding Engineer,

F. J. Lyautey, Pullman's Assistant QA/QC Manager,

J. P. Watson, Pullman's QC Welding Supervisor

dated 3/18/84 and submitted to the ASLB for consideration of Construction Quality Assurance matters at Diablo Canyon, Affidavit of F. C. Breismeister, Bechtel Manager of Research and Engineering,

C. M. Neary, H. W. Karner, Pullman's QA/QC Manager,

R. D. Kerr, PG&E Welding Engineer dated 3/19/84 and submitted to the ASLB.

1.0 WELDED STUDS

1.1 On January 13, 1984 a Pullman QC Inspector documented the use of ASTM A-307 and ASME SA-307 Grade B bolts for welded installations on hangers and supports for Class 1 safety related systems: 07 (Reactor Coolant), 08 (Chemical and Volume Control), 09 (Safety Injection), 10 (Residual Heat Removal), 12 (Containment Spray), and 14 (Component Cooling Water). The bolts were not specifically ordered to be made from a P-1 classified base material. The purchase orders for the bolts did not specify that the supplementary requirements for welded applications would be in effect. As stated in ASTM A-307-82a (Exhibit 1) the supplementary requirements shall apply only when specified in the purchase order or contract. Exhibit 1 was first presented by myself in a 3/21/84 affidavit to which PG&E has yet to show purchase orders showing supplementary requirements applicable.

1.2 PG&E has stated in DCL-84-195 at para. 226,241, DCL-84-239 at JIR-28 (pages 1-6) that the bolts installed without supplementary requirements in the purchase order for the bolts are acceptable because ASME Sec. III tells them so. Note that PG&E has conveniently left out where in Sec. III this is stated. What has PG&E got to lose from a full and open disclosure of the facts? Regardless, it is well known and universally practiced that the master P-Number list for materials and their weldability is found in Sec. IX of the ASME code.

1.3 For example Article IV, para. QW 421 of ASME-83, Sec. IX states "... base metals have beed assigned P-Numbers and for ferrous base metals which have specified impact test requirements, Group Numbers within P-Numbers. These assignments are based essentially on comparable base metal characteristics such as composition, weldability, and mechanical properties, where this can be logically done. These assignments do not imply that base metals may be indiscriminately substituted for a base metal which was used in a qualification test without consideration of compatibility from the standpoint of metallurgical properties, postweld heat treatment, design, mechanical properties, and service requirements."

1.4 Grouping of Base Metals for Qualification is the title for the master list of P-Numbers for procedure qualification purposes. QW-422 does not list A-307, grade B bolts as a P-1 base metal. Any claim to the contrary would be patently false. QW 422 is the place in the code where P-Numbers shall be determined and QW 422 is contained in Sec. IX; as it should be, behind the definition in QW 421 for a quick and final reference.

1.5 DCL-84-195 at 226 and 241, DCL-84-239 at JIR-28 (pages 2,5, and 6) allude to the Code Case N71-7 as qualifying A-307, grade B bolts installed at Diablo Canyon Project. Breismeister at 12 and 13 also presents this case stating that this proof qualifies A-307, grade B bolts as P-1 base metal. The USNRC Region V staff has also accepted the above citations as a final, "straw grabbing" qualification basis. Have any of the above individuals even read the text of the Case before citing its number? Conspicuously, the text was deleted from all references and no details were used to support the position.

1.6 ASME Section III Code Case N71-7 was approved 11/12/76 and annulled 11/21/80. The Case is no longer in effect because of a three year time restraint. This is an oversight PG&E forgot mention. Additional oversights noted are:

- Clearly citing the the full Code reference N-71-7 (1644-7),

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- Stating the time period of PG&E's contract specification verses the time N-71-7 was in effect,
- Clearly stating where in PG&E's contract specifications the Code Case had been implemented into design and quality assurance specifications for the project.

1.7 The title of Code Case N-71-1 Additional Materials for Component Supports Sec. III, Division 1 Subsection NF Class 1, 2,3 and MC Component Supports clearly defines its boundaries. The case was available only to nuclear power plants whose design and quality assurance programs were dedicated to ASME Sec. III. By PG&E's own admission in DCL-84-195, paragraph 250, "ASME Sections III and VIII only apply in a very limited degree to Pullman's scope of work at this site and are, therefore, not a part of the training program."

1.8 Had PG&E and the NRC Region V staff even read the Code Case text there were 7 conditions to be met. Three conditions are worthy of note:

- Adherence to Sec. III
- 0.35 % limit on carbon for base metals to be welded
- All supports built under the provisions of the Case be identified with the Case number.

Pullman had welded A-307 bolts with no limit on the percent of carbon, did not adhere to Sec. III, and did not identify the sup-

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ports where the special conditions of the code case applied. Pullman's quality assurance program was still struggling to meet its B 31.1 and B 31.7 commitments after 10 to 12 years of Diablo construction. To even imply that ASME Sec. III is applicable at Diablo in defense of welding A-307 grade B bolting material as structural members holding base plates on Class 1 systems is simply false and unsupported by the facts. ASME Sec. III Subsection NF, para. 4311.1 restricts stud welding to non-structural applications such as insulation, name plates, and locating lugs, Welded A-307 grade B bolts as reported per the January 13, 1984 Discrepency Report remain a Code non-conformance. PG&E's position has been one false statement after another in an inept coverup that just shows sloppy Code distortions to untenable positions. Note that PG&E and the NRC have not offered to consult the ASME Code writing body for conformation of their position; an act they should of done instead of wasting effort on useless Code citations that remain unsupported. ASME Code Case N-71-7 is openly presented as Exhibit 2.

2.0 INSPECTOR TRAINING

2.1 PG&E has attempted to support Pullman's position on QC inspector training in DCL-84-195 at 248-258, DCL-84-243 at III-51. Federal law and the capstone of Nuclear Quality Assurance programs for plant construction, Appendix B of 10 CFR 50, was conspicuously absent from not only Pullman's training program but also Pullman's reading list. See PG&E's response at 249 and attachment 9 to DCL-84-195. If PG&E's trump card for Pullman's inspector training program is the supplemental reading list shown as attachment 9, it's quite obvious, there was no training. The original allegation stated training was inadequate. Let's not prop up reading and pretend it's training.

2.2 Directly beneath the capstone is ANSI N45.2, Quality Assurance Program Requirements for Nuclear Facilities universally recognized to be in complete support with 10 CFR 50, Appendix B. Again, conspicuously absent from Pullman's training or reading assignments. PG&E proudly proclaims in the Final Safety Analysis Report, Chapter 17, bottom of page 17.0-1, "PG&E has actively contributed to the development of ANSI N45.2-1971, and the PG&E quality assurance program is in substantial agreement with it." PG&E's QA program is directly responsible for its contractors QA programs and why QC inspectors did not recieve direct training or even a referral to ANSI N45.2 is incomprehensible. Pullman QC inspectors were the very people responsible for the implementation of procedures, codes, and standards in the field working with the hardware that by law must be installed to the above requirements. The lack of training in ANSI N45.2 and the failure to even reference it to Pullman QC inspectors must be seen in the proper context; a complete and criminal failure to meet the quality assurance commitments stated in the FSAR.

2.3 DCL-84-195 at 251 shows the response PG&E's lawers provide to the lack of training accusations "... there is only an infrequent need for inspectors to interpret the code; they just need to understand what the code covers and the requirements of the specific inspection activity." Pullman's Procedures ESD 223 for piping supports and 243 for rupture restraints were patently lacking in code and construction standards adherence. Pullman's procedures were attempts to interpret the code, right or wrong, the QC inspector was then faced with interpreting the procedure. Hence, to say there was an infrequent need to interpret the codes is false and a patheticly weak response from lawers who know very little about inspection.

2.4 DCL-84-243 at III-51 states "It was not until 1983 that Pullman Power Products was first required by PG&E Specification 8711 to develop a Quality Assurance Program in accordance with ANSI N45.2." There you have it ladies and gentleman, straight from the horses mouth. Impossible as it may seem PG&E allowed the construction of Diablo Canyon to procede for twelve years without requiring its major piping and piping supports contractor to adhere to the industry standard ANSI N45.2. Yet PG&E has claimed thats its Quality Assurance Program is in substantial agreement with ANSI N45.2 (FSAR, page 17.0-1.) Perhaps PG&E would like to ellaborate on just how Pullman's Quality Assurance Program met the licensee's FSAR commitments before the change to the 8711 contract in 1983. I don't quite see how the hardware constructed to something less than the FSAR commitments to both ANSI N45.2 and 10 CFR 50, Appendix B is magically qualified.

2.5 PG&E's attitude is aptly explained in their response to my allegation that the Diablo Canyon Project (DCP) purposely failed to state to the Pullman QC inspector "you are certified to and responsible for ANSI N45.2.6 Level II capabilities." DCL-84-243 at III-51 (page 2) responds "There is no requirement anywhere that an inspector be specifically told that he is qualified to ANSI N45.2.6, and it should not make any practical difference wether or not the individual knows that he is qualified to N45.2.6." This is a false statement. ANSI N45.2.6-1973 states at 2.2.4 that the certificate of qualification shall include the basis used for certification. Pullman's certificate of qualification makes no mention of ANSI N45.2.6 as the basis of certification. As to wether it makes any difference the inspector know what he is certified to and responsible for, the same could be said for the contractor knowing what the utility is committed to in the Final Safety Analysis Report. Of course it makes a difference! Any words to the contrary are completely asinine.

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3.0 QC INSPECTOR HARASSMENT AND RETALIATION

3.1 In December of 1983, I had noted the failure of Pullman to conduct welder qualification testing under the full supervision and control of its ASME Sec. IX requirements. In attempting to document the extent of the problem, I was denied access to inspection records on the subject by the production foreman and QC Welding Supervisor involved in the testing. Three days after attempting to visually examine the test's inspection records I was fired.

3.2 In an affidavit presented before the ASLB, the QC Welding Supervisor, J. P. Watson, states on page 3, para. 4 "Records of each of the 13 Welder Performance Tests show QC inspection occured for fitup, rootpass, filler pass, final visual, and bend test." However, at the Department of Labor hearing conducted on my behalf July 11th and 12th Pullman QC Welding Supervisor, J. P. Watson, had a different response. The following is taken from court transcripts page 458 at 12 and ending on page 459 at 1.

> Q What records did you maintain of the tests that were undertaken during that time?
>
> A I just told you, I maintained my log, a record of each and every test that is performed, and the actual permanent certification that is made from the record.
>
> Q And the certification just states that so-and-so is certified as a welder under certain procedures?

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A There are regular forms for it, yes.

Q Did you-- Does your log reflect all the various hold points that you--

A No sir.

Q Did you--are there records of what hold points you examined?

A There are no permanent records, no required records for that purpose, No sir.

Mr. J. P. Watson has impeached himself under oath in attempting to have it both ways. Wether permanent, auditable, QC inspection records exist for welder qualification testing is still unknown.

3.3 With respect to welder qualification testing, I refer the reader to 10 CFR 50, Appendix B.

Criteria IX <u>CONTROL OF SPECIAL PROCESSES</u> "Measures shall be established to assure that special processes, including welding... are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements."

Criteria X <u>INSPECTION</u> A program for inspection of activities affecting quality shall be established and executed... to verify conformance with documented instructions, procedures, and drawings. Examinations, measurements, or tests of material or products processed shall be performed for each work operation where necessary to assure quality... If mandatory inspection holdpoints which require witnessing or inspecting by the applicants designated representative and beyond which work shall not proceed without the consent of its designated representative are required, the specific hold points shall be indicated in appropriate documents."

Criteria XI <u>TEST CONTROL</u> "... Test procedures shall include provisions for assuring that all prerequisites for the given test have been met, that adequate test instrumentation is available and used... Test results shall be documented and evaluated to assure that test requirements have been satisfied."

Criteria XIV <u>INSPECTION, TEST, AND OPERATING STATUS</u> "Measures shall be established to indicate by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections or tests. ... These measures shall provide for the identification of the items which have satisfactorilly passed required inspections and tests."

Criteria XVII <u>QUALITY ASSURANCE RECORDS</u> "Sufficient records shall be maintained to furnish evidence of activities affecting quality. The records shall include at least the following: operating logs and the results of reviews, inspections, tests, audits, monitoring of work performance... Inspection and test records shall, as a minimum, identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted."

3.4 The short review of appendix B was presented to ask and answer the questions:

♦ Are inspection records of welder qualification testing required at nuclear power facilities?

♦ Does the welder qualification test have hold points that must be inspected before the test can be allowed to proceed?

♦ If a QC inspector performed an inspection of a mandatory hold point, would that inspector be required to document the results of such an inspection?

In thirteen years of welder qualification testing at Diablo Canyon, has no one attempted to audit the inspection records for verification to the requirements of 10 CFR 50, Appendix B? PG&E's own FSAR states in chapter 17 Quality Assurance para. 17.1.10 "All suppliers and contractors on the Diablo Canyon Project are required to employ a program for inspection of their work to verify conformance with approved drawings, specifications, and procedures... Both process monitoring and inspection of final products are employed to confirm the quality of work. Records of inspections are maintained to demonstrate the quality of work. Suppliers and contractors routinely establish hold points on shop travelers or similar documents to be signed off by the suppliers' or contractors' inspectors."

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Federal law and PG&E's own FSAR indicate that records exist and shall be maintained to indicate hold points have been examined and recorded by quality assurance personnel. Yet, in December of 1983 I requested inspection records of welder qualification testing and was refused twice.

3.5 A false statement made before the ASLB in the affidavit of C. M. Neary, F. J. Lyautey, and J. P. Watson is the statement: "... Mr. Lockert admits he was shown records of welder qualification for the days in question (December 7,8, and 9, 1983) which documented the inspections performed by Mr. Watson on welder qualification tests." I state emphatically I was not shown inspection records for welder qualification testing. I had requested the records because I had observed that many of the inspections that were supposed to happen did not. I had observed a problem and was performing my duty as a QC inspector when the records were denied to me. I was obligated to report the problem and in attempting to do so was fired.

I have read the above 14 page affidavit and it is true and correct to the best of my knowledge and belief.

Steven Lockert

Steven Lockert

STATE OF CALIFORNIA
COUNTY OF San Luis Obispo } ss.

On 10/29/84, before me, the undersigned, a Notary Public in and for said State, personally appeared STEVEN LOCKERT personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same.

WITNESS my hand and official seal.

Signature Susan Hawkins

SUSAN HAWKINS
NOTARY PUBLIC-CALIFORNIA
PRINCIPAL OFFICE IN
SAN LUIS OBISPO COUNTY
My Commission Expires Jan. 25, 198?

(This area for official notarial seal)

Standard Specification for
CARBON STEEL EXTERNALLY THREADED STANDARD FASTENERS[1]

This standard is issued under the fixed designation A 307; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification[2] covers the chemical and mechanical requirements of two grades of carbon steel externally threaded standard fasteners, in sizes ¼ in. (6.35 mm) through 4 in. (104 mm). This specification does not cover requirements for externally threaded fasteners having heads with slotted or recessed drives or for mechanical expansion anchors. The fasteners covered by this specification are frequently used for the following applications:

1.1.1 *Grade A Bolts*, for general applications, and

1.1.2 *Grade B Bolts*, for flanged joints in piping systems where one or both flanges are cast iron.

1.2 If no grade is specified in the inquiry, contract, or order, Grade A bolts shall be furnished.

1.3 Nonheaded anchor bolts, either straight or bent, to be used for structural anchorage purposes, shall conform to the requirements of Specification A 36 with tension tests to be made on the bolt body or on the bar stock used for making the anchor bolts.

1.4 Suitable nuts are covered in Specification A 563. Unless otherwise specified, the grade and style of nut for each grade of fastener, of all surface finishes, shall be as follows:

Fastener Grade and Size	Nut Grade and Style[A]
A, ¼ to 1½ in.	A, hex
A, over 1½ to 4 in.	A, heavy hex
B, ¼ to 4 in.	A, heavy hex

[A] Nuts of other grades and styles having specified proof load stresses (Specification A 563, Table 3) greater than the specified grade and style of nut are also suitable.

1.5 The values stated in inch-pound units are to be regarded as the standard.

1.6 Supplementary Requirement S1 of an optional nature is provided, which describes additional restrictions to be applied when bolts are to be welded. It shall apply only when specified in the inquiry, order, and contract.

2. Applicable Documents

2.1 *ASTM Standards:*

A 36 Specification for Structural Steel[3]

A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[4]

A 370 Methods and Definitions for Mechanical Testing of Steel Products[5]

A 563 Specification for Carbon and Alloy Steel Nuts[6]

A 706 Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement[7]

A 751 Methods, Practices, and Definitions for Chemical Analysis of Steel Products[8]

B 454 Specification for Mechanically Deposited Coatings of Cadmium and Zinc on Ferrous Metals[9]

2.2 *American National Standards:*[10]

ANSI B1.1 Unified Screw Threads

ANSI B18.2.1 Square and Hex Bolts and Screws

3. Ordering Information

3.1 Orders for externally threaded fasteners (including nuts and accessories) under this specification shall include the following:

3.1.1 ASTM designation and date of issue,

3.1.2 Name of product, that is, hex or heavy hex,

3.1.3 Grade, that is, A or B (If no grade is specified, Grade A bolts are furnished,

3.1.4 Quantities (number of pieces by size including nuts),

3.1.5 Fastener size and length,

3.1.6 *Washers*—Quantity and size (separate from bolts),

3.1.7 *Galvanizing*—Specify hot dip, mechanical (4.4) or other finish required,

3.1.8 Specify if inspection at point of manufacture is required,

3.1.9 Specify if certified test report is required (see 9.2), and

3.1.10 Specify additional testing (9.3) or special requirements.

4. Materials and Manufacture

4.1 Steel for bolts shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

4.2 Bolts may be produced by hot or cold forging of the heads or machining from bar stock.

4.3 Bolt threads may be rolled or cut.

4.4 When specified, galvanized bolts shall be hot-dip zinc coated in accordance with the requirements of Class C of Specification A 153. When specified by the purchaser to be mechanically galvanized, bolts covered by this specification shall be mechan cally zinc coated and the coating and coated fasteners shall conform to the requirements for Class 50 of Specification B 454, or to the coating thickness, adherence, and quality requirements for Class C of Specification A 153.

5. Chemical Requirements

5.1 Steel shall conform to the following chemical requirements:

	Grade A Bolts	Grade B Bolts
Phosphorus, max, %	0.06	0.04

5.2 Resulfurized material is not subject to rejection based on product analysis for sulfur.

5.3 Bolts are customarily furnished from stock, in which case individual heats of steel cannot be identified.

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

5.5 Chemical analyses shall be performed in accordance with Methods A 751.

6. Mechanical Requirements

6.1 Bolts shall not exceed the maximum hardness required in Table 1. Bolts less than three diameters in length, or bolts with drilled or undersize heads shall have hardness values not less than the minimum nor more than the maximum hardness limits required in Table 1, as hardness is the only requirement.

6.2 Bolts 1½ in. in diameter or less, other than those excepted in 6.1, shall be tested full size and shall conform to the requirements for tensile strength specified in Table 2.

6.3 Bolts larger than 1½ in. in diameter, other than those excepted in 5.1, shall preferably be tested full size and when so tested, shall conform to the requirements for tensile strength specified in Table 2. When equipment of sufficient capacity for full-size bolt testing is not available, or when the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements shown below:

	Tensile Strength, ksi (MPa)	Elongation in 2 in. or 50 mm, %
Grade A and Grade B bolts	60 (415) min	18 min
Grade B bolts only	100 (690) max	...

In the event that bolts are tested by both full size and by machine test specimen methods, the full-size test shall govern if a controversy between the two methods exists.

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

7. Dimensions

7.1 Unless otherwise specified, threads shall be the Coarse Thread Series as specified in the latest issue of ANSI B1.1, having a Class 2A

EXHIBIT 1 (3 pages) pg. 1 of 3

[1] This specification is under the jurisdiction of ASTM Committee F-16 on Fasteners, and is the direct responsibility of Subcommittee F 16.02 on Steel Bolting.

Current edition approved May 28 and Aug. 27, 1982. Published October 1982. Originally published as A 307 – 47 T. Last previous edition A 307 – 80.

[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-307 in Section II of that Code.

[3] *1983 Annual Book of ASTM Standards*, Vol 01.04.

[4] *1983 Annual Book of ASTM Standards*, Vol 01.03.

[5] *1983 Annual Book of ASTM Standards*, Vol 01.01, 01.02, 01.03, 01.04, 01.05, and 15.08.

[6] *1983 Annual Book of ASTM Standards*, Vol 01.01 and 01.04.

[7] *1983 Annual Book of ASTM Standards*, Vol 01.04.

[8] *1983 Annual Book of ASTM Standards*, Vol 01.01, 01.02, 01.03, 01.04, 01.05, and 03.05.

[9] *1983 Annual Book of ASTM Standards*, Vol 01.04 and 02.05.

[10] May be obtained from American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018.

7.2 Unless otherwise specified, Grade A bolts shall be hex bolts with dimensions as given in the latest issue of ANSI B 18.2.1. Unless otherwise specified, Grade B bolts shall be heavy hex bolts with dimensions as given in the latest issue of ANSI B 18.2.4.

7.3 Unless otherwise specified, bolts to be used with nuts or tapped holes which have been tapped oversize, in accordance with Specification A 563, shall have Class 2A threads before hot dip or mechanical galvanizing. After galvanizing, the maximum limit of pitch and major diameter may exceed the Class 2A limit by the following amount:

Diameter, in.	Oversize Limit, in. (mm)[A]
Up to 7/16, incl	0.016 (0.41)
Over 7/16 to 1, incl	0.021 (0.53)
Over 1	0.031 (0.79)

[A] These values are the same as the minimum overtapping required for galvanized nuts in Specification A 563.

7.4 The gaging limit for bolts shall be verified during manufacture or use by assembly of a nut tapped as nearly as practical to the amount oversize shown above. In case of dispute, a calibrated thread ring gage of that same size (Class X tolerance, gage tolerance plus) shall be used. Assembly of the gage, or the nut described above, must be possible with hand effort following application of light machine oil to prevent galling and damage to the gage. These inspections, when performed to resolve disputes, shall be performed at the frequency and quality described in Table 3.

8. Test Methods

8.1 The material shall be tested in accordance with Supplement III of Methods A 370.

8.2 Standard square and hex head bolts only shall be tested by the wedge tension method except as noted in 6.1. Fracture shall be in the body or threads of the bolt without any fracture at the junction of the head and body. Other headed bolts shall be tested by the axial tension method.

8.3 Speed of testing as determined with a free running crosshead shall be a maximum of 1 in. (25.4 mm)/min for the tensile strength tests of bolts.

9. Number of Tests and Retests

9.1 The requirements of this specification shall be met in continuous mass production for stock, and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of individual shipments of material are not ordinarily contemplated. Individual heats of steel are not identified in the finished product.

9.2 When specified in the order, the manufacturer shall furnish a test report certified to be the last completed set of mechanical tests for each stock size in each shipment.

9.3 When additional tests are specified on the purchase order, a lot, for purposes of selecting test samples, shall consist of all material offered for inspection at one time that has the following common characteristics:

9.3.1 One type of item,

9.3.2 One nominal size, and

9.3.3 One nominal length of bolts.

9.4 From each lot, the number of tests for each requirement shall be as follows:

Number of Pieces in Lot	Number of Samples
800 and under	1
801 to 8 000	2
8 001 to 22 000	3
Over 22 000	5

9.5 If any machined test specimen shows defective machining it may be discarded and another specimen substituted.

9.6 Should any sample fail to meet the requirements of a specified test, double the number of samples from the same lot shall be tested, in which case all of the additional samples shall meet the specification.

10. Marking

10.1 Bolt heads shall be marked (by raised or depressed mark at the option of the manufacturer) to identify the manufacturer. The manufacturer may use additional marking for his own use.

11. Inspection

11.1 If the inspection described in 11.2 is required by the purchaser it shall be specified in the inquiry, order, or contract.

11.2 The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the works.

12. Rejection

12.1 Unless otherwise specified, any reje tion based on tests specified herein shall reported to the manufacturer within 30 workin days from the receipt of samples by the pu chaser.

SUPPLEMENTARY REQUIREMENT

The following supplementary requirement shall apply only when specified in th purchase order or contract:

S1. Bolts Suitable for Welding

S1.1 The material described in this section is intended for welding. This supplemental section, by additional chemical composition restrictions and by a carbon equivalent formula, provides assurance of weldability by chemical composition control.

S1.2 Welding technique is of fundamental importance when bolts produced to this supplementary section are welded. It is presupposed that suitable welding procedures for the steel being welded and the intended service will be selected.

S1.3 All of the requirements of this supplemental section apply in addition to all of the chemical, mechanical, and other requirements of the base specification, A 307 for Grade B.

S1.4 Because of the embrittling effects of welding temperatures on cold-forged steel, this supplemental section is limited to hot-forged bolts, or, if not forged, then to bolts produced from hot-rolled bars without forging or threaded bars, bars studs, or stud bolts produced from hot-rolled bars without forging. Cold-forged bolts, or cold-drawn threaded bars, if they are given a thermal treatment by heating to a temperature of not less than 1500°F (815°C) and air-cooled are also suitable.

S1.5 *Chemical Requirements*:

S1.5.1 *Heat Chemical Analysis*—Material conforming to the following additional analysis limitations shall be used to manufacture the product described in this supplementary r quirement.

Carbon	0.30 %, max
Manganese	1.00 %, max
Phosphorus	0.04 %, max
Sulfur	0.05 %, max
Silicon	0.50 %, max

S1.5.2 *Carbon Equivalent (Source—AST Specification A 706)*—In addition to the hea chemical analysis requirements in S1.5.1, th heat analysis shall be such as to provide carbon equivalent (CE) not exceeding 0.5 when calculated as follows:

$$CE = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} + \frac{\%Mo}{50} - \frac{\%V}{10}$$

S1.6 *Analysis Reports*—If requested on th order or contract, the chemical composition o each heat of steel used and the calculated car bon equivalent for each heat shall be reporte to the purchaser.

S1.7 Product (Check) Verification Analy sis—A Chemical analysis may be made by th purchaser or his representative from bolts se lected from each heat of steel. The analysis thu determined shall not exceed the values speci fied in S1.5.2 by more than the followin amounts.

	%
Carbon	+0.03
Manganese	+0.06
Phosphorus	+0.008
Sulfur	+0.008
Silicon	+0.05

EX. 1 pg. 2 of 3

TABLE 1 Hardness Requirements for Bolts

Bolt Size, in.	Grade	Hardness			
		Brinell		Rockwell B	
		min	max	min	max
All	A	121	241[A]	69	100[A]
	B	121	212	69	95

[A] Except when tested by wedge tension test.

TABLE 2 Tensile Requirements for Full-Size Bolts

Bolt Size, in.	Threads per inch	Stress Area[A] in.²	Tensile Strength, lbf[B]	
			Grades A and B, min[C]	Grade B only, max[D]
1/4	20	0.0318	1 900	3 180
5/16	18	0.0524	3 100	5 240
3/8	16	0.0775	4 650	7 750
7/16	14	0.1063	6 350	10 630
1/2	13	0.1419	8 500	14 190
9/16	12	0.182	11 000	18 200
5/8	11	0.226	13 550	22 600
3/4	10	0.334	20 050	33 400
7/8	9	0.462	27 700	46 200
1	8	0.606	36 350	60 600
1 1/8	7	0.763	45 800	76 300
1 1/4	7	0.969	58 150	96 900
1 3/8	6	1.155	69 300	115 500
1 1/2	6	1.405	84 300	140 500
1 3/4	5	1.90	114 000	190 000
2	4 1/2	2.50	150 000	250 000
2 1/4	4 1/2	3.25	195 000	325 000
2 1/2	4	4.00	240 000	400 000
2 3/4	4	4.93	295 800	493 000
3	4	5.97	358 200	597 000
3 1/4	4	7.10	426 000	710 000
3 1/2	4	8.33	499 800	833 000
3 3/4	4	9.66	579 600	966 000
4	4	11.08	664 800	1 108 000

[A] Area calculated from the formula:

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

where:

A_s = stress area,
D = nominal diameter of bolt, and
n = threads per inch.

[B] 1 lbf = 4.448 N.
[C] Based on 60 ksi (414 MPa).
[D] Based on 100 ksi (689 MPa).

TABLE 3 Sample Sizes and Acceptance Numbers for Inspection of Hot Dip or Mechanically Galvanized Threads

Lot Size	Sample Size[A, B]	Acceptance Number[A]
2 to 90	13	1
91 to 150	20	2
151 to 280	32	3
281 to 500	50	5
501 to 1 200	80	7
1 201 to 3 200	125	10
3 201 to 10 000	200	14
10 001 and over	315	21

[A] Sample sizes of acceptance numbers are extracted from "Single Sampling Plan for Normal Inspection" Table IIA, MIL-STD-105D.
[B] Inspect all bolts in the lot if the lot size is less than the sample size.

EX. 1 pg. 3 of 3

ASTM Designation: A 320 – 82

Standard Specification for ALLOY STEEL BOLTING MATERIALS FOR LOW-TEMPERATURE SERVICE[1]

This standard is issued under the fixed designation A 320; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This specification has been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This specification[2] covers alloy steel bolting materials for pressure vessels, valves, flanges, and fittings for low-temperature service. The term "bolting material" as used in this specification covers rolled, forged, or strain hardened bars, bolts, screws, studs, and stud bolts. The bars shall be hot-wrought. The material may be further processed by centerless grinding or by cold drawing. Austenitic stainless steel may be solution annealed or annealed and strain-hardened.

1.2 Several grades are covered, including both ferritic and austenitic steels designated L7, B8, etc. Selection will depend on design, service conditions, mechanical properties, and low-temperature characteristics.

NOTE 1—The committee formulating this specification has included several grades of material that have been rather extensively used for the present purpose. Other compositions will be considered for inclusion by the committee from time to time as the need becomes apparent. Users should note that hardenability of some of the grades mentioned may restrict the maximum size at which the required mechanical properties are obtainable.

1.3 Nuts for use with this bolting material are covered in Section 9.

1.4 Supplementary Requirement S1 of an optional nature is provided. It shall apply only when specified in the inquiry, contract and order.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 *ASTM Standards*:

A 29 Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished[3]

A 194 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service[4]

A 276 Specification for Stainless and Heat-Resisting Steel Bars and Shapes[3]

A 325 Specification for High-Strength Bolts for Structural Joints[5]

A 370 Methods and Definitions for Mechanical Testing of Steel Products[4]

2.2 *American National Standards Institute Standards*:[6]

B18.2.1 Square and Hex Bolts and Screws

B18.3 Hexagon Socket and Spline Socket Screws

B18.22.1 Plain Washers

3. Ordering Information

3.1 The inquiry and order for material under this specification shall include the following as required to describe the material adequately:

3.1.1 ASTM Designation A 320 latest issue, and analysis by grade as selected from Table 1,

3.1.2 Minimum mechanical properties re-

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Valves and Fittings.

Current edition approved July 30, 1982. Published September 1982. Originally published as A 320 – 48 T. Last previous edition A 320 – 81.

[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-320 in Section II of that Code.

[3] *1983 Annual Book of ASTM Standards*, Vol 01.05.

[4] *1983 Annual Book of ASTM Standards*, Vol 01.01.

[5] *1983 Annual Book of ASTM Standards*, Vol 01.04.

[6] Available from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Meeting of September 16, 1977
Approved by Council, November 21, 1977

This Case shall expire on November 21, 1980
unless previously annulled or reaffirmed.

Case N-71-7 (1644-7)
Additional Materials for Component Supports
Section III, Division 1, Subsection NF Class 1, 2, 3, and MC Component Supports

Inquiry: What materials, in addition to those listed in Tables I-11.0, I-12.0, and I-13.0 of Appendix I of Section III, Division 1, may be used for Class 1, 2, 3, or MC component supports constructed to the requirements of Subsection NF?

Reply: It is the opinion of the Committee that the additional materials, design stress intensity and allowable stress values, the yield strength, and the ultimate tensile strength values[1], listed in Tables 1, 2, 3, 4, and 5 of this Code Case may be used in the construction of Class 1, 2, 3, and MC Component supports for Section III, Division 1, in addition to those listed in Table NF-2121(a)-1

The following additional requirements shall apply:

(1) All other requirements of Subsection NF shall be met including NF-2586, where applicable.

(2) Until rules are added, welding is not permitted on carbon and low alloy steels containing more than 0.35 percent carbon, nor on PH[2] or age-hardened[2] steels, nor on materials to Specifications ASTM A514-75 and SA-592, nor on the free machining[2] steels permitted in (3) below.

(3) When the Nominal Composition column references AISI grades, only materials meeting the chemical composition requirements of the specific AISI grades listed shall be used, with the exception that 0.60 maximum silicon is permitted for castings. Free machining[2] modifications of the specific AISI grades listed may be used at the same design stress intensities, allowable stresses and yield strengths of the reference grades but their use is limited to 400 F maximum temperature.

(4) When welding on A487-76 Grade 10Q, SA-508 Class 4, A508-76 Class 4a and A543-74 Class 1, 2, and 3, the following additional requirements shall apply:

(a) Welding procedure qualification and welder and welding operator qualification shall be made in accordance with Section IX as modified by Section III and as given herein.

(b) Separate welding procedure qualification of Section IX shall be required for these materials and combinations of other materials with these materials. When joints are made between two different types or grades of base material, a procedure qualification must be made for applicable combinations of materials even though procedure qualification tests have been made for each of the two base materials welded to itself (materials of the same nominal chemical analysis and mechanical properties range, even though of different product form, may be considered as the same type or grade).

(c) The following, in addition to the variables in Sec. IX, QW-250, shall be considered as essential variables requiring re-qualification of the welding process.

1. A change in filler metal SFA classification or to a weld metal not covered by an SFA specification.

2. An increase in the maximum or a decrease in the minimum specified preheat or interpass temperatures. The specified range of preheat temperatures shall not exceed 150 F.

3. A change in the heat treatment (procedure qualification tests shall be subjected to heat-treatment essentially equivalent to that encountered in fabrication

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[1] The tabulated values of tensile strength and yield strength are those which the Committee believes are suitable for use in design calculations required by Section III, Division 1. At the temperatures above room temperature, the values of tensile strength tend toward an average or expected value which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. Neither the tensile strength nor the yield strength values correspond exactly to either "average" or "minimum" as these terms are applied to a statistical treatment of a homogeneous set of data.

Neither the ASME or ASTM Material Specifications nor the Rules of Section III, Division 1, require elevated temperature testing for tensile or yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile and yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material suggesting the possibility of some error) further investigation by retest or other means should be considered.

[2] The designer shall consider the effects of temperature, environment and applied stress on the material properties of precipitation or age hardening alloys, on other high strength heat treated alloys, or on freemachining steels.

of the vessel or vessel parts including the maximum total aggregate time at temperature or temperatures and cooling rates).

4. A change in the types of current (AC or DC) polarity, or a change in the specified range for amperage, volt, or travel speed.

5. A change in the thickness (T) of the welding procedure qualification test plate as follows:

(a) For welded joints which are quenched and tempered after welding, any increase in thickness (the minimum thickness qualified in all cases is ½ in.).

(b) For welded joints which are not quenched and tempered after welding, any change as follows:

T	
less than 5/8 in.	Any decrease in thickness (The maximum thickness qualified is $2T$)
5/8 in. and over	Any departure from the range of 5/8 in. to $2T$.

(d) Welding filler metal containing more than 0.06 percent vanadium shall not be used.

(e) In addition to the requirements of NB-4410 of Section III, Division 1, the materials may require rebaking in order to minimize moisture. The procedures for doing this for covered arc welding electrodes are given in Specifications SFA-5.1 and SFA-5.5.

(f) The radius of the mandrel or die used in the guided bend tests of Section IX, Figs. QW-466.1, QW-466.2, and QW-466.3 shall be:

Thickness of Specimen, in.	A in.	B in.	C in.	D in.
3/8	$2\frac{1}{2}$	$1\frac{1}{4}$	$3\frac{3}{8}$	$1\frac{11}{16}$
t	$6\frac{2}{3}t$	$3\frac{1}{3}t$	$8\frac{2}{3}t+\frac{1}{8}$	$4\frac{1}{4}t+\frac{1}{16}$

(g) The final postweld heat treatment shall be at a minimum temperature of 1075 F and a maximum temperature limited only by the ability to meet the specified mechanical properties. Minimum holding time at the final postweld heat treating temperature shall be one hour per inch of weld thickness, one hour minimum.

(5) When the ASTM specification referenced in Tables 1 through 5 does not specify minimum tensile and yield strengths, the values listed under the appropriate columns shall be met by the material.

(6) Materials in Tables 1 through 5 whose nominal composition is referenced as an AISI composition may be accepted as satisfying the requirements of the ASTM specification provided the chemical requirements of the AISI specification are within the specified range of the designated ASTM specification, and certification of the material shall be in accordance with the requirements of NCA-3867.4 (e) or (f). The term "each piece of stock material" in NCA-3867.4 (e) may be taken to refer to that portion of the material of the same heat and lot which has traceability established by the Manufacturer through his program. Where Certificates of Compliance are acceptable under Subsection NF, testing of each piece is not required.

(7) All supports and component standard supports constructed under the provisions of this Case shall be identified with this Case number.

TABLE 1

Design Stress Intensity Values, S_m, for Ferritic Steels and Copper Alloys for Class 1 Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Design Stress Intensity, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
										100	200	300	400	500	600	650	700	750	800
Carbon Steels																			
			Bar	A108-73	1015CW	–	6,9												
AISI 1015, 1018,1020	–	–	Bar	A108-73	1018CW	–	5,9	40	60	20.0	20.0	20.0	20.0	–	–	–	–	–	–
	–	–	Bar	A108-73	1020CW	–	6,9												
AISI 1045	–	–	Bar	A108-73	1045CW	–	2	100	120	40.0	40.0	40.0	40.0	–	–	–	–	–	–
AISI 1050	–	–	Bar	A108-73	1050CW	–	2	125	140	46.7	46.7	46.7	46.7	–	–	–	–	–	–
AISI 1015	–	–	Tube	A513-76	1015CW	–	6,9	55	65	21.7	21.7	21.7	21.7	–	–	–	–	–	–
AISI 1020	–	–	Tube	A513-76	1020CW	–	6,9	60	70	23.3	23.3	23.3	23.3	–	–	–	–	–	–
AISI 1025	–	–	Tube	A513-76	1025CW	–	6,9	65	75	25.0	25.0	25.0	25.0	–	–	–	–	–	–
AISI 1018, 1020,1022	–	–	Tube	A519-76	1018CW 1022CW	–	5,7,9	50	70	23.3	23.3	23.3	23.3	–	–	–	–	–	–
	–	–	Tube	A519-76	1020HR 1022HR	–	–	32	60	20.0	20.0	20.0	20.0	–	–	–	–	–	–
AISI 1026	–	–	Tube	A519-76	1026HR	–	–	40	70	23.3	23.3	23.3	23.3	–	–	–	–	–	–
AISI 1026	–	–	Tube	A519-76	1026CW	–	5,7,11	60	80	26.7	26.7	26.7	26.7	–	–	–	–	–	–
	–	–	Bar	SA-675	65	–	–	32.5	65	21.7	21.7	21.7	21.7	21.7	21.7	21.7	–	–	–
	–	–	Bar	SA-675	70	–	–	35	70	23.3	23.3	23.3	23.3	23.3	23.3	23.3	–	–	–
	–	–	Bar	A675-77	75	–	–	37	75	25.0	25.0	25.0	25.0	25.0	25.0	25.0	–	–	–
AISI 1022, 1030	–	–	Forging	A668-72	–	B	–	30	60	20.0	20.0	20.0	20.0	20.0	20.0	20.0	–	–	–
Low Alloy Steels																			
AISI 4130, 4330	4	2	Casting	A148-73	90-60	–	8	60	90	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	–	–
AISI 4130,	–	–	Casting	A148-73	105-85	–	2	85	105	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	–	–
4140,4330,	–	–	Casting	A148-73	120-95	–	1,2	95	120	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	–	–
4340	–	–	Casting	A148-73	150-125	–	1,2	125	150	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	–	–
2¼Cr-1 Mo	5	2	Casting	A487-76	–	8Q	–	85	105	35.0	35.0	34.6	33.8	33.6	33.6	33.4	33.1	–	–

TABLE 1 (Cont'd)
Design Stress Intensity Values, S_m, for Ferritic Steels and Copper Alloys for Class 1 Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Design Stress Intensity, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Low Alloy Steels (Cont'd)																			
Ni-Cr-Mo	–	–	Casting	A487-76	–	10Q	1	100	125	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	–	–
Ni-Cr-Mo	–	–	Forging	A508-76	–	4a	1	100	115	38.3	38.3	38.3	37.9	37.6	37.1	–	–	–	–
			Plate	A514-75	All	–	1,2,3	100	110	36.7	36.7	36.7	36.7	36.7	36.7	36.6	35.9	–	–
			Plate	A514-75	All	–	1,2,4	90	100	33.3	33.3	33.3	33.3	33.3	33.3	33.2	32.6	–	–
AISI 4140, 4142	–	–	Tube	A519-76	4140CW	–	2	100	120	40.0	40.0	40.0	40.0	–	–	–	–	–	–
			Tube	A519-76	4142CW	–	2	100	120	40.0	40.0	40.0	40.0	–	–	–	–	–	–
2¼Cr-1 Mo	5	2	Plate	A542-77	–	3	–	75	95	31.7	31.7	31.7	31.7	31.5	31.1	30.8	30.4	–	–
2¼Cr-1 Mo	5	2	Plate	A542-77	–	4	–	60	85	28.3	28.3	28.3	28.3	28.2	27.8	27.5	27.2	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	1	–	85	105	35.0	35.0	35.0	34.6	34.4	33.9	–	–	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	2	1	100	115	38.3	38.3	38.3	37.9	37.6	37.1	–	–	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	3	–	70	90	30.0	30.0	30.0	29.7	29.5	29.1	–	–	–	–
			Plate,Shapes	A572-77a	42	–	–	42	60	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	–	–
			Plate,Shapes	A572-77a	50	–	–	50	65	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	–	–
5Ni-Cr-Mo-V	–	–	Forging	A579-76	12a	–	1,2	140	150	50.0	49.5	48.0	47.0	47.0	47.0	46.0	44.0	–	–
Mn-Cr-Cu-V	–	–	Plate	A588-77a	A,B	–	12	42	63	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	–	–
Mn-Ni-Cr-Cu-V	–	–	Plate	A588-77a	A,B	–	13	46	67	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	–	–
			Plate,Shapes	A588-77a	A,B	–	14	50	70	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	–	–
Mn-Cb	–	–	Plate	A633-75	A	–	–	42	63	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.8	–	–
Mn-V	–	–	Plate	A633-75	B	–	–												
Mn-Cb	–	–	Plate	A633-75	C,D	–	3	50	70	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.1	–	–
Mn-Cr-Ni-Cu	–	–	Plate	A633-75	C,D	–	4	46	60	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.8	–	–
Mn-V-N	–	–	Plate	A633-75	E	–	5	60	80	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.4	–	–
AISI 8620	3	3	Forging	A668-72	–	K	10	75	100	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	–	–
AISI 4140, 4340	–	–	Forging	A668-72	–	K	2,10												
AISI 4140, 4340	–	–	Forging	A668-72	–	L	2,10	85	110	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7	–	–
AISI 4330, 4340	–	–	Forging	A668-72	–	M	1,2,10	110	135	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	–	–
AISI 4340	–	–	Forging	A668-72	–	N	1,2,10	130	160	53.3	53.3	53.3	53.3	53,3	53.3	53.3	53.3	–	–

TABLE 1 (Cont'd)
Design Stress Intensity Values, S_m, for Ferritic Steels and Copper Alloys for Class 1 Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Design Stress Intensity, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
										100	200	300	400	500	600	650	700	750	800
Copper and Copper Alloys																			
Alum. Bronze	–	–	Bar	SB-150	642	–	–	25	70	16.7	14.3	13.3	13.2	–	–	–	–	–	–
80-10-10	–	–	Casting	SB-584	937	–	–	12	30	8.0	7.1	6.7	6.5	–	–	–	–	–	–

Notes

1. The maximum tensile strength shall not exceed the minimum specified tensile strength by more than 40.0 ksi. Where the Specification does not limit hardness, the maximum surface hardness shall not exceed the hardness values corresponding to the maximum tensile strength, as determined from the applicable Tables in SA-370.
2. Until rules for welding on this material are added, this material is not for welded construction.
3. Up to 2½ in. incl.
4. Over 2½ in. to 4 in.
5. These materials are limited for use only for snubbers and constant supports.
6. Max BHN 215.
7. Max BHN 225.
8. The elongation and reduction of area requirements for this material may be specified as 17% and 35% minimum, respectively.
9. When welding is required, the allowable stress values of A519, 1020HR shall apply.
10. For each forging 100 lbs. net weight and less, the marking requirements of A668-72 may be met by a suitable code or symbol identified by the Manufacturer in his Certificate of Compliance. The hardness test requirement shall be performed only on the tensile test specimen.
11. When welding is required, the allowable stress values of A519, 1026HR shall apply.
12. Over 5 in. to 8 in.
13. Over 4 in. to 5 in.
14. Plates up to 4 in. incl. and all structural shapes.

TABLE 2
Allowable Stress Values, S, for Ferritic Steels and Copper Alloys for Classes 2, 3, and MC Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Allowable Stress, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed 100	200	300	400	500	600	650	700	750	800
Carbon Steels																			
AISI 1015,1018	–	–	Bar	A108-73	1015CW														
1020	–	–	Bar	A108-73	1018CW	–	6,9	40	60	15.0	15.0	15.0	15.0	–	–	–	–	–	–
			Bar	A108-73	1020CW														
AISI 1045	–	–	Bar	A108-73	1045CW	–	2	100	120	30.0	30.0	30.0	30.0	–	–	–	–	–	–
AISI 1050	–	–	Bar	A108-73	1050CW	–	2	125	140	35.0	35.0	35.0	35.0	–	–	–	–	–	–
AISI 1015	–	–	Tube	A513-76	1015CW	–	6,9	55	65	16.3	16.3	16.3	16.3	–	–	–	–	–	–
AISI 1020	–	–	Tube	A513-76	1020CW	–	6,9	60	70	17.5	17.5	17.5	17.5	–	–	–	–	–	–
AISI 1025	–	–	Tube	A513-76	1025CW	–	6,9	65	75	18.8	18.8	18.8	18.8	–	–	–	–	–	–
AISI 1018,1020	–	–	Tube	A519-76	1018CW, 1022CW	–	5,7,9	50	70	17.5	17.5	17.5	17.5	–	–	–	–	–	–
1022	–	–	Tube	A519-76	1020HR, 1022HR	–	–	32	60	15.0	15.0	15.0	15.0	–	–	–	–	–	–
AISI 1026	–	–	Tube	A519-76	1026HR	–	–	40	70	17.5	17.5	17.5	17.5	–	–	–	–	–	–
AISI 1026	–	–	Tube	A519-76	1026CW	–	5,7,11	60	80	20.0	20.0	20.0	20.0	–	–	–	–	–	–
AISI 1022,1030	–	–	Forging	A668-72	–	B	–	30	60	15.0	15.0	15.0	15.0	15.0	15.0	15.0	–	–	–
Low Alloy Steels																			
AISI 4130,4330	4	2	Casting	A148-73	90-60	–	8	60	90	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	–	–
AISI 4130,4140,	–	–	Casting	A148-73	105-85	–	2	85	105	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	–	–
4330,4340	–	–	Casting	A148-73	120-95	–	1,2	95	120	30.0	30.0	30.6	30.0	30.0	30.0	30.0	30.0	–	–
			Casting	A148-73	150-125	–	1,2	125	150	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	–	–
2¼Cr-1 Mo	5	2	Casting	A487-76	–	8Q	–	85	105	26.3	26.3	26.0	25.3	25.2	25.2	25.0	24.8	–	–
Ni-Cr-Mo	–	–	Casting	A487-76	–	10Q	1	100	125	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	–	–
Ni-Cr-Mo	–	–	Forging	A508-76	–	4a	1	100	115	28.7	28.7	28.7	28.4	28.2	27.8	–	–	–	–
	–	–	Plate	A514-75	All	–	1,2,3	100	110	27.5	27.5	27.5	27.5	27.5	27.5	27.4	26.9	–	–
	–	–	Plate	A514-75	All	–	1,2,4	90	110	25.0	25.0	25.0	25.0	25.0	25.0	24.9	24.5	–	–

TABLE 2 (Cont'd)
Allowable Stress Values, S, for Ferritic Steels and Copper Alloys for Classes 2, 3, and MC Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Allowable Stress, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Low Alloy Steels (Cont'd)																			
AISI 4140,4142	–	–	Tube	A519-76	4140CW	–	2	100	120	30.0	30.0	30.0	30.0	–	–	–	–	–	–
			Tube	A519-76	4142CW														
2¼Cr-1 Mo	5	2	Plate	A542-77	–	3	–	75	95	23.8	23.8	23.8	23.8	23.7	23.3	23.1	22.8	–	–
2¼Cr-1 Mo	5	2	Plate	A542-77	–	4	–	60	85	21.3	21.3	21.3	21.3	21.1	20.8	20.7	20.4	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	1	–	85	105	26.2	26.2	26.2	26.0	25.8	25.4	25.1	24.7	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	2	1	100	115	28.7	28.7	28.7	28.4	28.2	27.8	27.5	27.0	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	3	–	70	90	22.5	22.5	22.5	22.3	22.1	21.8	21.5	21.2	–	–
Mn-Cb-V	–	–	Plate,Shapes	A572-77a	42	–	–	42	60	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	–	–
Mn-Cb-V	–	–	Plate,Shapes	A572-77a	50	–	–	50	65	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	–	–
5Ni-Cr-Mo-V	–	–	Forging	A579-76	12a	–	12	140	150	37.5	37.1	36.0	35.1	35.1	35.1	34.5	33.0	–	–
Mn-Cr-Cu-V	–	–	Plate	A588-77a	A,B	–	12	42	63	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	–	–
Mn-Ni-Cr-Cu-V	–	–	Plate	A588-77a	A,B	–	13	46	67	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	–	–
			Plate,Shapes	A588-77a	A,B	–	14	50	70	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	–	–
Mn-Cb	–	–	Plate	A633-75	A	–	–	42	63	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.6	–	–
Mn-V	–	–	Plate	A633-75	B	–	–												
Mn-Cb	–	–	Plate	A633-75	C,D	–	3	50	70	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.3	–	–
Mn-Cr-Ni-Cu	–	–	Plate	A633-75	C,D	–	4	46	60	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.9	–	–
Mn-V-N	–	–	Plate	A633-75	E	–	5	60	80	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.8	–	–
	–	–	Bar	SA-675	65	–	–	32.5	65	16.3	16.3	16.3	16.3	16.3	16.3	16.3	–	–	–
	–	–	Bar	SA-675	70	–	–	35	70	17.5	17.5	17.5	17.5	17.5	17.5	17.5	–	–	–
	–	–	Bar	A675-76	75	–	–	37	75	18.8	18.8	18.8	18.8	18.8	18.8	18.8	–	–	–
AISI 8620	3	3	Forging	A668-72	–	K	10	75	100	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	–	–
AISI 4140,4340	–	–	Forging	A668-72	–	K	2,10												
AISI 4140,4340	–	–	Forging	A668-72	–	L	2,10	85	110	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	–	–
AISI 4330,4340	–	–	Forging	A668-72	–	M	1,2,10	110	135	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	–	–
AISI 4340	–	–	Forging	A668-72	–	N	1,2,10	130	160	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	–	–

TABLE 2 (Cont'd)
Allowable Stress Values, *S*, for Ferritic Steels and Copper Alloys for Classes 2, 3, and MC Plate and Shell Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Allowable Stress, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Copper and Copper Alloys																			
Alum. Bronze	–	–	Bar	SB-150	612	–	–	25	70	16.7	14.0	15.5	11.0	–	–	–	–	–	–
80-10-10	–	–	Casting	SB-584	937	–	–	12	30	27.5	7.0	6.6	6.4	–	–	–	–	–	–

Notes
1. The maximum tensile strength shall not exceed the minimum specified tensile strength by more than 40.0 ksi. Where the Specification does not limit hardness, the maximum surface hardness shall not exceed the hardness values corresponding to the maximum tensile strength, as determined from the applicable Tables in SA-370.
2. Until rules for welding on this material are added, this material is not for welded construction.
3. Up to 2½ in. incl.
4. Over 2½ in. to 4 in.
5. These materials are limited for use only for snubbers and constant supports.
6. Max BHN 215.
7. Max BHN 225.
8. The elongation and reduction of area requirements for this material may be specified as 17% and 35% minimum, respectively.
9. When welding is required, the allowable stress values of A519, 1020HR shall apply.
10. For each forging 100 lbs. net weight and less, the marking requirements of A668-72 may be met by a suitable code or symbol identified by the Manufacturer in his Certificate of Compliance. The hardness test requirement shall be performed only on the tensile test specimen.
11. When welding is required, the allowable stress values of A519, 1026HR shall apply.
12. Over 5 in. to 8 in.
13. Over 4 in. to 5 in.
14. Plates up to 4 in. incl. and all structural shapes.

EXHIBIT 2, 21 pages (313-326.8)

TABLE 3

Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Yield Strength, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed 100	200	300	400	500	600	650	700	750	800
Copper and Copper Alloys																			
Cu-Zn-Pb	–	–	Bar	B16-76	360	–	1" & under	25	55	25.0	–	–	–	–	–	–	–	–	–
							over 1" to 2"	20	50	20.0	–	–	–	–	–	–	–	–	–
Cu-Zn-Pb	–	–	Forging	B124-77	377	–	–	18	50	18.0	16.3	14.9	14.2	–	–	–	–	–	–
Alum. Bronze	–	–	Bar	SB-150	612	–	–	25	70	25.0	21.5	20.0	19.8	–	–	–	–	–	–
80-10-10	–	–	Casting	SB-584	937	–	–	12	30	12.0	10.6	10.0	9.9	–	–	–	–	–	–
Carbon Steels																			
AISI 1015,1018, 1020	–	–	Bar	A108-73	1015CW	–	7,11	40	60	40.0	36.5	35.4	34.2	–	–	–	–	–	–
	–	–	Bar	A108-73	1018CW	–	7,11												
			Bar	A108-73	1020CW	–	7,11												
AISI 1045	–	–	Bar	A108-73	1045CW	–	2	100	120	100.0	91.2	88.4	85.6	–	–	–	–	–	–
AISI 1050	–	–	Bar	A108-73	1050CW	–	2	125	140	125.0	114.0	110.5	107.0	–	–	–	–	–	–
AISI 1117	–	–	Bar	A108-73	1117	–	2,6	70	80	70.0	63.8	61.9	59.9	–	–	–	–	–	–
AISI 1144	–	–	Bar	A108-73	1144	–	2,6	81	105	81.0	73.9	71.6	69.3	–	–	–	–	–	–
AISI 1214	–	–	Bar	A108-73	1214	–	2,6	65	75	65.0	59.3	57.5	55.6	–	–	–	–	–	–
	–	–	Wire	A228-76	C	–	2,6,16	250	270	250.0	220.5	202.5	187.5	–	–	–	–	–	–
	1	1	Plate	SA-283	C	–	–	30	55	30.0	27.3	26.6	25.7	–	–	–	–	–	–
	1	1	Plate	A284-75	B	–	–	27.5	55	27.5	25.0	24.3	23.6	–	–	–	–	–	–
	–	–	Pipe	A381-76	–	Y35	–	35	60	35.0	31.9	31.0	30.0	28.3	25.9	25.6	25.2	–	–
	–	–	Tb.Shp.	A500-76	B	–	–	42	58	42.0	38.3	37.2	35.9	33.9	31.0	30.4	30.2	–	–
	–	–	Tb.Shp.	A500-76	C	–	–	46	62	46.0	41.9	40.8	39.4	37.2	34.0	33.3	33.1	–	–
	–	–	Str.Tb.	A501-76	–	–	–	36	58	36.0	32.8	31.9	30.8	29.1	26.6	26.1	25.9	–	–
AISI 1015	–	–	Tube	A513-75	1015CW	–	6,8,11	55	65	55.0	50.2	48.6	47.1	–	–	–	–	–	–
AISI 1020	–	–	Tube	A513-75	1020CW	–	6,8,11	60	70	60.0	54.7	53.0	51.4	–	–	–	–	–	–
AISI 1025	–	–	Tube	A513-75	1025CW	–	6,8,12	65	75	65.0	59.3	57.5	55.6	–	–	–	–	–	–
AISI 1015,1018, 1020,1022	–	–	Tube	A519-76	1015CW	–	6,8,11	50	70	50.0	45.6	44.2	42.8	–	–	–	–	–	–
			Tube	A519-76	1018CW	–													
			Tube	A519-76	1020CW	–													
			Tube	A519-76	1022CW	–													
			Tube	A519-76	1018HR	–	6,8	32	60	32.0	29.2	28.3	27.4	–	–	–	–	–	–
			Tube	A519-76	1020HR	–													
AISI 1026	–	–	Tube	A519-76	1026HR	–	–	40	70	40.0	36.5	35.4	34.2	–	–	–	–	–	–
			Tube	A519-76	1026CW	–	6,8,12	60	80	60.0	54.7	53.0	51.4	–	–	–	–	–	–

TABLE 3 (Cont'd)
Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	100	200	300	400	500	600	650	700	750	800
										Yield Strength, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
AISI 1020,	–	–	Forging	A521-76	–	CC	9	30	60	30.0	27.3	26.6	25.7	24.3	22.2	21.8	21.6	–	–
1030,1035,	–	–	Forging	A521-76	–	CE	9	37	75	37.0	33.7	32.8	31.7	29.9	27.4	26.9	26.6	–	–
1040	–	–	Forging	A521-76	>4"<10"	CG	2,9	50	85	50.0	45.6	44.3	42.9	40.4	57.0	36.3	36.0	–	–
	–	–	Forging	A521-76	<4"	CG	2,9	55	90	55.0	50.1	48.7	47.1	44.5	40.7	39.9	39.6	–	–
	–	–	Plate	A570-75	C	–	–	33	52	33.0	30.1	29.2	28.3	26.5	24.4	24.1	23.8	–	–
	–	–	Plate	A570-75	E	–	–	42	58	42.0	38.2	37.1	35.9	33.7	31.0	30.6	30.2	–	–
AISI 1022,1030	–	–	Forging	A668-72	–	B	–	30	60	30.0	27.3	26.6	25.7	24.3	22.2	21.8	21.6	–	–
AISI 1020,1030	–	–	Forging	A668-72	–	C	–	33	66	33.0	30.1	29.2	28.3	26.5	24.4	24.1	23.8	–	–
AISI 1020,1030	–	–	Forging	A668-72	–	D	–	37.5	75	37.5	34.2	33.2	32.1	30.3	27.7	27.2	27.0	–	–
AISI 1035	–	–	Forging	A668-72	–	F	2,9	50	85	50.0	45.6	44.3	42.3	40.4	36.9	36.3	36.0	–	–
Low Alloy Steels																			
AISI 4130,4330	4	2	Casting	A148-73	90-60	–	10	60	90	60.0	58.2	55.9	52.8	50.1	49.8	49.8	49.8	–	–
AISI 4130,4140	–	–	Casting	A148-73	105-85	–	2	85	105	85.0	82.5	79.2	74.8	71.0	70.5	70.5	70.5	–	–
4330,4340	–	–	Casting	A148-73	120-95	–	1,2	95	120	95.0	92.1	88.5	83.5	79.3	78.9	78.9	78.9	–	–
			Casting	A148-73	150-125	–	1,2	125	150	125.0	121.1	116.5	110.0	104.3	103.9	103.9	103.9	–	–
AISI 4150	–	–	Bar	A322-76	4150	–	2	100	115	100.0	93.5	90.2	87.8	85.1	81.4	73.9	76.0	–	–
AISI 8620	–	–	Bar	A331-76	8620CW	–	6,12	75	90	75.0	70.1	67.7	65.8	63.8	61.0	59.0	57.0	–	–
AISI 4320,	–	–	Bar	A434-76	–	BB	1,2	90	110	90.0	84.1	81.3	79.0	76.6	73.3	71.0	68.4	–	–
4130,4140,	–	–	Bar	A434-76	–	BB	2	80	105	80.0	74.8	72.3	70.3	68.1	65.1	63.1	60.9	–	–
4145,4330,	–	–	Bar	A434-76	–	BB	2	75	100	75.0	70.1	67.7	65.8	63.8	61.0	59.1	57.0	–	–
4340,8620	–	–	Bar	A434-76	–	BB	2	75	95	75.0	70.1	67.7	65.8	63.8	61.0	59.0	57.0	–	–
			Bar	A434-76	–	BB	2	65	90	65.0	60.7	58.6	57.1	55.3	52.9	51.2	49.4	–	–
AISI 4130,	–	–	Bar	A434-76	–	BC	1,2	110	130	110.0	102.9	99.4	96.6	93.6	89.5	86.8	83.6	–	–
4140,4145,	–	–	Bar	A434-76	–	BC	1,2	105	125	105.0	98.1	94.8	92.2	89.4	85.5	82.9	79.8	–	–
4330,4340	–	–	Bar	A434-76	–	BC	1,2	95	115	95.0	88.5	85.4	83.0	80.6	77.0	74.6	72.0	–	–
			Bar	A434-76	–	BC	2	85	110	85.0	79.5	76.8	74.6	72.4	69.1	67.0	64.6	–	–
			Bar	A434-76	–	BC	2	80	105	80.0	74.8	72.3	70.3	68.1	65.1	63.1	60.9	–	–
AISI 4130,	–	–	Bar	A434-76	–	BD	1,2	130	155	130.0	121.5	117.2	114.1	110.7	105.7	102.5	93.8	–	–
4140,4145	–	–	Bar	A434-76	–	BD	1,2	120	150	120.0	112.1	108.4	105.2	102.1	97.6	94.6	91.1	–	–
4330,4340	–	–	Bar	A434-76	–	BD	1,2	110	140	110.0	102.9	99.4	96.6	93.6	89.5	86.8	83.6	–	–
			Bar	A434-76	–	BD	1,2	105	135	105.0	98.1	94.8	92.2	89.4	88.5	82.9	79.8	–	–
			Bar	A434-76	–	BD	1,2	100	130	100.0	93.5	90.2	87.8	85.1	81.4	78.9	76.0	–	–

TABLE 3 (Cont'd)

Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	100	200	300	400	500	600	650	700	750	800
										Yield Strength, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
3Ni-Cr-Mo-V	–	–	Forging	A471-70	–	2	1,2	85	105	85.0	80.1	77.5	75.8	74.6	73.3	72.2	71.2	–	–
			Forging	A471-70	–	3	1,2	95	110	95.0	89.5	86.6	84.7	83.4	81.9	80.7	79.6	–	–
			Forging	A471-70	–	4	1,2	105	120	105.0	99.0	95.8	93.7	92.1	90.6	89.2	88.0	–	–
			Forging	A471-70	–	5	1,2	115	130	115.0	103.4	104.9	102.6	100.9	99.2	97.7	96.4	–	–
3Ni-Cr-Mo-V	–	–	Forging	A471-70	–	6	1,2	125	140	125.0	117.8	114.0	111.5	109.7	107.8	106.2	104.8	–	–
			Forging	A471-70	–	7	1,2	135	150	135.0	127.1	123.0	120.3	118.3	116.2	114.8	113.1	–	–
			Forging	A471-70	–	8	1,2	145	160	145.0	136.6	132.2	129.3	127.1	124.9	123.2	121.8	–	–
			Forging	A471-70	–	9	1,2	155	170	155.0	146.0	141.2	138.1	136.0	133.5	131.8	130.0	–	–
2¼Cr-1 Mo	5	2	Casting	A487-76	–	8Q	–	85	105	85.0	78.5	76.1	74.5	73.2	71.7	70.9	70.0	–	–
Ni-Cr-Mo	–	–	Casting	A487-76	–	10Q	1	100	125	100.0	97.0	93.2	88.0	83.5	83.0	83.0	83.0	–	–
Ni-Cr-Mo	–	–	Forging	A508-76	–	4a	1	100	115	100.0	94.2	91.2	89.2	87.7	86.1	–	–	–	–
			Plate	A514-75	All	–	1,2,3	100	110	100.0	95.5	92.5	89.8	87.6	85.5	84.3	83.0	–	–
			Plate	A514-75	All	–	1,2,4	90	100	90.0	86.0	83.3	80.8	78.8	77.0	75.9	74.7	–	–
AISI 4140,	–	–	Tube	A519-76	4140CW														
4142	–	–	Tube	A519-76	4142CW	–	2	100	120	100.0	93.5	90.2	87.8	–	–	–	–	–	–
2¼ Cr-1 Mo	5	2	Plate	A542-77	–	3	–	75	95	75.0	72.0	70.3	68.9	67.7	66.4	65.6	64.8	–	–
2¼ Cr-1 Mo	5	2	Plate	A542-77	–	4	–	60	85	60.0	57.6	56.2	55.1	54.1	53.1	52.5	51.8	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	1	–	85	105	85.0	80.0	77.5	75.8	74.5	73.2	–	–	–	–
Ni-Cr-Mo	–	–	Plate	A543-77	A,B	2	1	100	115	100.0	94.2	91.2	89.2	87.7	86.1	–	–	–	–
			Plate	A543-77	A,B	3	–	70	90	70.0	65.9	63.8	62.4	61.4	60.3	59.5	58.7	–	–
	–	–	Plate, Bar, Shapes	A572-77a	42	–	–	42	60	42.0	40.0	38.3	36.8	35.2	33.5	32.7	31.8	–	–
	–	–	Plate, Bar, Shapes	A572-77a	50	–	–	50	65	50.0	47.5	45.6	43.8	41.8	39.9	38.9	37.9	–	–
5Ni-Cr-Mo-V	–	–	Forging	A579-76	12a	–	1,2	140	150	140.0	138.6	134.0	129.5	127.7	126.3	123.5	117.6	–	–
			Plate, Bar	A588-77a	A,B	–	13	42	63	42.0	40.0	38.3	36.8	35.2	33.5	32.7	31.8	–	–
Mn-Cr-Cu-V	–	–	Plate, Bar	A588-77a	A,B	–	14	46	67	46.0	43.8	41.9	40.3	38.6	36.7	35.8	34.8	–	–
Mn-Ni-Cr-Cu-V	–	–	Plate, Bar, Shapes	A588-77a	A,B	–	15	50	70	50.0	47.5	45.6	43.0	41.8	39.9	38.9	37.9	–	–
	–	–	Forging	SA-592	A,E,F	–	1,2	100	115	100.0	95.5	92.5	89.8	89.6	85.5	84.3	83.0	–	–
	–	–	Forging	SA-592	A,E,F	–	1,2	90	105	90.0	86.0	83.3	80.8	78.8	77.0	75.9	74.7	–	–
Mn-Co-V	–	–	Tube	A618-74	II	–	–	50	70									–	–
Mn-V	–	–	Tube	A618-74	III	–	–	50	65	50.0	45.4	41.7	38.0	34.6	33.9	33.6	33.1	–	–
Mn-Cb	–	–	Plate	A633-75	A														
Mn-V	–	–	Plate	A633-75	B	–	–	42	63	42.0	38.2	35.1	31.9	29.1	28.5	28.2	27.8	–	–

TABLE 3 (Cont'd)
Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Yield Strength, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Mn-Cb	–	–	Plate	A633-75	C,D	–	3	50	70	50.0	45.4	41.7	38.0	34.6	33.9	33.6	33.1	–	–
Mn-Cr-Ni-Cu	–	–	Plate	A633-75	C,D	–	4	46	60	46.0	41.8	38.4	35.0	31.8	31.2	30.9	30.4	–	–
Mn-V-N	–	–	Plate	A633-75	E	–	6	60	80	60.0	54.5	50.1	45.6	41.5	40.7	40.3	39.7	–	–
AISI 4140,	–	–	Forging	A668-72	K	–	2,9	80	105	80.0	74.8	72.3	70.3	68.1	65.1	63.1	60.9	–	–
4340,8620	–	–	Forging	A668-72	K	–	2,9	75	100	75.0	70.1	67.7	65.8	63.8	61.0	59.0	57.0	–	–
AISI 4140,	–	–	Forging	A668-72	L	–	1,2,9	105	125	105.0	98.1	94.8	92.2	89.4	85.5	82.9	79.8	–	–
4340	–	–	Forging	A668-72	L	–	1,2,9	95	115	95.0	88.5	85.4	83.0	80.6	77.0	74.6	72.0	–	–
			Forging	A668-72	L	–	2,9	85	110	85.0	79.5	76.8	74.6	72.4	69.1	67.0	64.6	–	–
AISI 4330,	–	–	Forging	A668-72	M	–	1,2,9	120	145	120.0	112.1	108.4	105.2	102.1	97.6	91.6	91.1	–	–
4340	–	–	Forging	A668-72	M	–	1,2,9	115	140	115.0	107.5	103.8	101.0	98.0	93.6	90.0	87.5	–	–
			Forging	A668-72	M	–	1,2,9	110	135	110.0	102.9	99.4	96.6	93.6	89.5	86.8	83.6	–	–
AISI 4340	–	–	Forging	A668-72	N	–	1,2,9	140	170	140.0	131.0	126.3	123.0	119.1	114.0	110.4	106.3	–	–
			Forging	A668-72	N	–	1,2,9	135	165	135.0	126.1	121.9	118.5	115.0	108.9	106.5	102.7	–	–
			Forging	A668-72	N	–	1,2,9	130	160	130.0	121.5	117.2	114.1	110.7	105.7	102.5	98.8	–	–
High Alloy Steels																			
Precipitation Hardened Steels																			
15Cr-4Ni-4Cu	–	–	Bar, Forg.	A564-74	XM12	–	1,2	145	155	145.0	136.0	130.7	125.8	121.7	117.2	115.2	112.9	–	–
15Cr-4Ni-4Cu	–	–	Bar, Forg.	A564-74	XM12	–	1,2	125	145	125.0	117.1	112.6	108.3	104.8	101.0	99.5	97.2	–	–
13Cr-8Ni-2Mo	–	–	Bar, Forg.	A564-74	XM13	–	1,2,5	165	175	165.0	154.6	148.5	143.0	138.1	133.8	131.1	128.4	–	–
Stainless Steels																			
AISI 302,304, 316,317	–	–	Wire	A580-76	B	–	2,16	100	125	100.0	83.3	75.0	69.0	–	–	–	–	–	–

TABLE 3 (Cont'd)

Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Notes

1. The maximum tensile strength shall not exceed the minimum specified tensile strength by more than 40.0 ksi. Where the Specification does not limit hardness, the maximum surface hardness shall not exceed the hardness values corresponding to the maximum tensile strength, as determined from the applicable Tables in SA-370.
2. Until rules for welding on this material are added, this material is not for welded construction.
3. Up to 2½ in. incl.
4. Over 2½ to 4 in.
5. A564 Type XM-13 shall be modified so that age hardening treatment shall be 1050 F only.
6. These materials are limited for use only for snubbers and constant supports.
7. Max BHN 215.
8. Max BHN 225.
9. For each forging 100 lbs net weight and less, the marking requirements of A668-72 may be met by a suitable code or symbol identified by the Manufacturer in his Certificate of Compliance. The hardness test requirement shall be performed only on the tensile test specimen.
10. The elongation and reduction of area requirements for this material may be specified at 17% and 35% minimum, respectively.
11. When welding is required, the allowable stress values of A519, 1020HR shall apply.
12. When welding is required, the allowable stress values of A519, 1026HR shall apply.
13. Over 5 in. to 8 in.
14. Over 4 in. to 5 in.
15. Plates up to 4 in. incl. and all structural shapes.
16. This material may be used only in fully constrained applications, such as thread inserts, so that failure of the wire would not affect the function of the component support.

TABLE 4
Yield Strength Values, S_y, for Bolting Materials for Classes 1, 2, 3, and MC Supports[5]

Nominal Composition	P-No.	Group No.	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Yield Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Carbon Steels																		
AISI 1045	–	–	A108-73	1045CW	–	2	100	125	100.0	91.2	88.4	85.6	–	–	–	–	–	–
AISI 1050	–	–	A108-73	1050CW	–	2	125	140	125.0	114.0	110.5	107.0	–	–	–	–	–	–
AISI 1141	–	–	A108-73	1141	–	2,8	81	105										
AISI 1144	–	–	A108-73	1144	–	2,9	81	105	81.0	73.9	71.6	69.3	–	–	–	–	–	–
AISI 1214	–	–	A108-73	1214	–	2,8	81	105										
AISI 1144	–	–	A108-73	1144	–	2,8	105	125	105.0	95.8	92.8	89.8	–	–	–	–	–	–
	–	–	SA-194	2H	–	2,7	–	–	81.0	73.9	71.6	69.3	–	–	–	–	–	–
	–	–	A307-76b	A	–	2	36	58	36.0	32.8	31.9	30.8	29.1	26.6	26.1	25.9	–	–
	–	–	SA-325	–	–	2	81	105	81.0	73.9	71.6	69.3	–	–	–	–	–	–
AISI 1040	–	–	A574-76	1040	–	2	135	170	135.0	123.1	119.3	115.6	–	–	–	–	–	–
Low Alloy Steels																		
AISI 4137, 4140	–	–	SA-320	L7B	<2½	2,6	105	125	105.0	98.0	94.1	91.5	–	–	–	–	–	–
AISI 1030, 1035, 1040, 1045, 1050	–	–	SA-449	–	<1 in.	2	85	125	85.0	77.5	75.1	72.8	–	–	–	–	–	–
	–	–	SA-449	–	>1<1½	2	74	105	74.0	67.5	65.4	63.3	–	–	–	–	–	–
	–	–	SA-449	–	1½ to 3	2	55	90	55.0	50.2	48.6	47.1	–	–	–	–	–	–
AISI 4135, 4140, 4340	–	–	A490-76a	–	–	2,4,6	130	150	130.0	121.5	117.2	114.1	110.7	108.7	102.5	98.8	–	–
AISI 4140, 4340	–	–	A574-76	–	–	2,4,6	135	170	135.0	126.2	121.7	118.5	115.0	112.9	106.4	102.6	–	–
Precipitation Hardened Steels																		
13Cr-8Ni-2Mo	–	–	A564-74	XM-13	–	2,3,6	165	175	165.0	154.6	148.5	143.0	138.1	133.3	131.1	128.4	–	–
Austenitic Stainless Steels																		
AISI 304	8	1	SA-193	B3	1	–												
AISI 304	8	1	SA-193	B8A	1A	–	30	75	30.0	25.0	22.5	20.7	19.4	18.2	17.9	17.7	17.3	16.8
AISI 347	8	1	SA-193	B8C	1	–												
AISI 347	8	1	SA-193	B8CA	1A	–	30	75	30.0	27.5	25.6	23.9	22.5	21.4	21.0	20.6	20.5	20.3
AISI 316	8	1	SA-193	B8M	1	–												
AISI 316	8	1	SA-193	B8MA	1A	–	30	75	30.0	25.8	23.3	21.4	19.9"	18.8	18.5	18.1	17.8	17.6
AISI 321	8	1	SA-193	B8T	1	–												
AISI 321	8	1	SA-193	B8TA	1A	–	30	75	30.0	25.4	22.7	20.6	19.1	18.2	17.8	17.5	17.3	17.2
AISI 304	8	1	SA-194	B8	–	10	–	–	–	–	–	–	–	–	–	–	–	–
AISI 347	8	1	SA-194	B8C	–	10	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 4 (Cont'd)
Yield Strength Values, S_y, for Bolting Materials for Classes 1, 2, 3, and MC Supports[5]

Nominal Composition	P-No.	Group No.	Specification No.	Type or Grade	Class	Notes	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Yield Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
AISI 316	8	1	SA-194	B8M	–	10	–	–	–	–	–	–	–	–	–	–	–	–
AISI 321	8	1	SA-194	B8T	–	10	–	–	–	–	–	–	–	–	–	–	–	–

Notes

1. All A307 bolts shall, in addition, meet both the chemical and mechanical requirements for SA-36 bar material. Welding is permitted.
2. No welding permitted.
3. A564, Type XM-13, shall be modified so that age hardening treatment shall be 1050 F, only.
4. Minimum Tempering Temperature shall be 850 F.
5. Allowable tensile, shearing and bending stresses for the bolt and threaded part materials of Table 4 shall not exceed the values given in paragraph (7) of this Case.
6. The maximum tensile strength shall not exceed the minimum specified tensile strength by more than 40.0 ksi. Where the Specification does not limit hardness, the maximum surface hardness shall not exceed the hardness values corresponding to the maximum tensile strength, as determined by the applicable Tables in SA-370.
7. No yield or tensile strength specified. Assume to be the same as A325 type 1 bolts for nut design calculations.
8. 3 in. maximum diameter, cold drawn and tempered.
9. 10 in. maximum diameter.
10. No yield strength or tensile strength specified. Assume to be the same strength as SA-193 bolting material of the equivalent grade for nut design calculations.

TABLE 5
Ultimate Tensile Stress Values, S_u, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Copper and Copper Alloys																		
Cu-Zn-Pb	–	–	Bar	B16-76	360	–	25	55	55.0	–	–	–	–	–	–	–	–	–
							20	50	50.0	–	–	–	–	–	–	–	–	–
Cu-Zn-Pb	–	–	Forging	B124-77	377	–	18	50	50.0	45.5	40.0	34.0	–	–	–	–	–	–
Alum. Bronze	–	–	Bar	SB-150	642	–	25	70	70.0	69.5	68.5	66.0	–	–	–	–	–	–
80-10-10	–	–	Casting	SB-584	937	–	12	30	30.0	26.8	24.8	24.5	–	–	–	–	–	–
Carbon Steels																		
AISI 1015, 1018,	–	–	Bar	A108-73	1015CW													
1020	–	–	Bar	A108-73	1018CW	–	40	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
			Bar	A108-73	1020CW													
AISI 1045	–	–	Bar	A108-73	1045CW	–	100	120	120.0	120.0	120.0	120.0	–	–	–	–	–	–
AISI 1050	–	–	Bar	A108-73	1050CW	–	125	140	140.0	140.0	140.0	140.0	–	–	–	–	–	–
AISI 1117	–	–	Bar	A108-73	1117	–	70	80	80.0	80.0	80.0	80.0	–	–	–	–	–	–
AISI 1144	–	–	Bar	A108-73	1144	–	81	105	105.0	105.0	105.0	105.0	–	–	–	–	–	–
AISI 1214	–	–	Bar	A108-73	1214	–	65	75	75.0	75.0	75.0	75.0	–	–	–	–	–	–
			Wire	A228-76	C	–	250	270	270.0	270.0	270.0	270.0	–	–	–	–	–	–
	1	1	Plate	SA-283	C	–	30	55	55.0	55.0	55.0	55.0	–	–	–	–	–	–
	1	1	Plate	A284-75	B	–	27.5	55	55.0	55.0	55.0	55.0	–	–	–	–	–	–
	–	–	Pipe	A381-76	–	Y35	35	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
	–	–	Tb. Shp.	A500-76	B	–	42	58	58.0	58.0	58.0	58.0	–	–	–	–	–	–
	–	–	Tb. Snp.	A500-76	C	–	46	62	62.0	62.0	62.0	62.0	–	–	–	–	–	–
	–	–	Str. Tb.	A501-76	–	–	36	58	58.0	58.0	58.0	58.0	–	–	–	–	–	–
AISI 1015	–	–	Tube	A513-75	1015CW	–	55	65	65.0	65.0	65.0	65.0	–	–	–	–	–	–
AISI 1020	–	–	Tube	A513-75	1020CW	–	60	70	70.0	70.0	70.0	70.0	–	–	–	–	–	–
AISI 1025	–	–	Tube	A513-75	1025CW	–	65	75	75.0	75.0	75.0	75.0	–	–	–	–	–	–
			Tube	A519-76	1015CW	–												
			Tube	A519-76	1018CW	–												
AISI 1015, 1018,	–	–	Tube	A519-76	1020CW	–	50	70	70.0	70.0	70.0	70.0	–	–	–	–	–	–
1020, 1022	–	–	Tube	A519-76	1022CW	–												
			Tube	A519-76	1018HR	–												
			Tube	A519-76	1020HR	–	32	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
AISI 1026	–	–	Tube	A519-76	1026HR	–	40	70	70.0	70.0	70.0	70.0	–	–	–	–	–	–
			Tube	A519-76	1026CW	–	60	80	80.0	80.0	80.0	80.0	–	–	–	–	–	–

TABLE 5 (Cont'd)

Ultimate Tensile Stress Values, S_U, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	100	200	300	400	500	600	650	700	750	800
									Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
AISI 1020,	–	–	Forging	A521-76	–	CC	33	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
1030, 1035,	–	–	Forging	A521-76	–	CE	37	75	75.0	75.0	75.0	75.0	–	–	–	–	–	–
1040	–	–	Forging	A521-76	>4" ≤8"	CG	50	85	85.0	85.0	85.0	85.0	–	–	–	–	–	–
	–	–	Forging	A521-76	<4"	CG	55	90	90.0	90.0	90.0	90.0	–	–	–	–	–	–
	1	1	Pipe	SA-524	I	–	35	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
	1	1	Pipe	SA-524	II	–	30	55	55.0	55.0	55.0	55.0	–	–	–	–	–	–
	–	–	Plate	A570-75	C	–	33	52	52.0	52.0	52.0	52.0	–	–	–	–	–	–
	–	–	Plate	A570-75	E	–	42	58	58.0	58.0	58.0	58.0	–	–	–	–	–	–
Mn-V-N	–	–	Plate	A633-75	E	–	60	80	80.0	80.0	80.0	80.0	80.0	80.0	80.0	78.2	–	–
	–	–	Forging	A668-72	–	B	30	60	60.0	60.0	60.0	60.0	–	–	–	–	–	–
AISI 1020, 1030	–	–	Forging	A668-72	–	C	33	66	66.0	66.0	66.0	66.0	–	–	–	–	–	–
AISI 1020, 1030	–	–	Forging	A668-72	–	D	37.5	75	75.0	75.0	75.0	75.0	–	–	–	–	–	–
AISI 1035	–	–	Forging	A668-72	–	F	50	85	85.0	85.0	85.0	85.0	–	–	–	–	–	–
	1	1	Bar	SA-675	65	–	32.5	65	65.0	65.0	65.0	65.0	–	–	–	–	–	–
	1	2	Bar	SA-675	70	–	35	70	70.0	70.0	70.0	70.0	–	–	–	–	–	–
	–	–	Bar	A675-76	75	–	37	75	75.0	75.0	75.0	75.0	–	–	–	–	–	–
Low Alloy Steels																		
AISI 4130, 4330	4	2	Casting	A148-73	90-60	–	60	90	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	–	–
AISI 4130, 4140,	–	–	Casting	A148-73	105-85	–	85	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	–	–
4330, 4340	–	–	Casting	A148-73	120-95	–	95	120	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	–	–
			Casting	A148-73	150-125	–	125	150	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	–	–
9 Cr-1 Mo	5	2	Casting	SA-217	C12	–	60	90	90.0	89.6	84.8	84.8	84.8	84.8	83.9	82.4	–	–
AISI 4150	–	–	Bar	A322-76	4150	–	100	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	–	–
AISI 8620	–	–	Bar	A331-74	8620CW	–	75	90	90.0	90.0	90.0	90.0	–	–	–	–	–	–
AISI 4320,	–	–	Bar	A434-76	–	BB	90	110	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	–	–
4130, 4140,	–	–	Bar	A434-76	–	BB	80	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	–	–
4145, 4330,	–	–	Bar	A434-76	–	BB	75	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	–	–
4340, 8620	–	–	Bar	A434-76	–	BB	75	95	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	–	–
			Bar	A434-76	–	BB	65	90	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	–	–
AISI 4130,	–	–	Bar	A434-76	–	BC	110	130	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	–	–
4140, 4145,	–	–	Bar	A434-76	–	BC	105	125	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	–	–
4330, 4340	–	–	Bar	A434-76	–	BC	95	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	–	–
	–	–	Bar	A434-76	–	BC	85	110	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	–	–
	–	–	Bar	A434-76	–	BC	80	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	–	–

TABLE 5 (Cont'd)

Ultimate Tensile Stress Values, S_u, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed 100	200	300	400	500	600	650	700	750	800
AISI 4130,	–	–	Bar	A434-76	–	BD	130	155	155.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0	–	–
4140, 4145,	–	–	Bar	A434-76	–	BD	120	150	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	–	–
4330, 4340	–	–	Bar	A434-76	–	BD	110	140	140.0	140.0	140.0	140.0	140.0	140.0	140.0	140.0	–	–
	–	–	Bar	A434-76	–	BD	105	135	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	–	–
	–	–	Bar	A434-76	–	BD	100	130	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	–	–
			Forging	A471-70	–	2	85	105	105.0	105.0	105.0	104.0	103.3	101.9	100.4	98.8	–	–
			Forging	A471-70	–	3	95	110	110.0	110.0	110.0	108.9	108.1	106.7	105.1	103.5	–	–
			Forging	A471-70	–	4	105	120	20.0	120.0	120.0	118.8	118.0	116.4	114.7	112.9	–	–
3Ni-Cr-Mo-V	–	–	Forging	A471-70	–	5	115	130	130.0	130.0	130.0	128.7	127.8	126.1	124.3	122.3	–	–
			Forging	A471-70	–	6	125	140	140.0	140.0	140.0	138.5	137.7	135.8	133.8	131.7	–	–
			Forging	A471-70	–	7	135	150	150.0	150.0	150.0	148.5	147.5	145.5	143.4	141.1	–	–
			Forging	A471-70	–	8	145	160	160.0	160.0	160.0	158.4	157.3	155.2	152.9	150.5	–	–
			Forging	A471-70	–	9	155	170	170.0	170.0	170.0	168.3	167.2	164.9	162.5	159.9	–	–
Mn-V	10A	1	Casting	SA-487	–	1N	55	85	85.0	85.0	85.0	85.0	85.0	84.3	82.7	80.4	–	–
Mn-½Mo	10F	6	Casting	SA-487	–	2N	53	85	85.0	85.0	84.7	84.6	84.6	84.6	84.6	84.6	–	–
2¼Cr-1 Mo	5	2	Casting	A487-76	–	8Q	85	105	105.0	105.0	105.0	105.0	104.5	103.1	102.1	101.0	–	–
Ni-Cr-Mo	–	–	Casting	A487-76	–	10Q	100	125	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	–	–
Ni-Cr-Mo	3	3	Forging	SA-508	–	2	50	80	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	–	–
Ni-Cr-Mo	3	3	Forging	SA-508	–	3	50	80	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	–	–
Ni-Cr-Mo	–	–	Forging	SA-508	–	4	85	105	105.0	105.0	105.0	104.0	103.2	101.8	100.4	98.8	–	–
Ni-Cr-Mo	–	–	Forging	A508-76	–	4a	100	115	115.0	115.0	115.0	113.9	113.1	111.4	110.0	108.1	–	–
	–	–	Plate	A514-75	All	–	100	110	110.0	110.0	110.0	110.0	110.0	110.0	110.0	107.7	–	–
	–	–	Plate	A514-75	All	–	90	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.9	–	–
AISI 4140, 4142	–	–	Tube	A519-76	4140CW	–	100	120	120.0	120.0	120.0	120.0	–	–	–	–	–	–
			Tube	A519-76	4142CW	–	100	120	120.0	120.0	120.0	120.0	–	–	–	–	–	–
AISI 4330, 4340	–	–	Bar	SA-540	B21, B22, B23, B24	1	150	165	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	–	–
AISI 4330, 4340	–	–	Bar	SA-540	B21, B22, B23, B24	2	140	155	155.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0	–	–
AISI 4330, 4340	–	–	Bar	SA-540	B21, B22, B23, B24	3	130	145	145.0	145.0	145.0	145.0	145.0	145.0	145.0	145.0	–	–
AISI 4330, 4340	–	–	Bar	SA-540	B21, B22, B23, B24	4	120	135	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	–	–

TABLE 5 (Cont'd)
Ultimate Tensile Stress Values, S_U, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed									
									100	200	300	400	500	600	650	700	750	800
AISI 4330, 4340	—	—	Bar	SA-540	B21, B22, B23, B24	5	100	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	—	—
AISI 4330, 4340	—	—	Bar	SA-540	B21, B22, B23, B24	5	105	120	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	—	—
2¼Cr-1 Mo	5	2	Plate	A542-77	—	3	75	95	95.0	95.0	95.0	95.0	94.6	93.2	92.4	91.4	—	—
2¼Cr-1 Mo	5	2	Plate	A542-77	—	4	60	85	85.0	85.0	85.0	85.0	84.6	83.4	82.6	81.7	—	—
Ni-Cr-Mo	—	—	Plate	A543-77	A,B	1	85	105	105.0	105.0	105.0	104.0	103.3	101.9	100.4	98.8	—	—
Ni-Cr-Mo	—	—	Plate	A543-77	A,B	2	100	115	115.0	115.0	115.0	113.9	113.1	111.5	109.9	108.4	—	—
	—	—	Plate	A543-77	A,B	3	70	90	90.0	90.0	90.0	89.1	88.6	87.3	86.0	84.7	—	—
	—	—	Plate, Bar, Shapes	A572-77a	42	—	42	60	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	—	—
	—	—	Plate, Bar, Shapes	A572-77a	50	—	50	65	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	—	—
5Ni-Cr-Mo-V	—	—	Forging	A579-76	12a	—	140	150	150.0	148.5	144.0	141.0	141.0	141.0	138.0	132.0	—	—
			Plate, Bar	A588-77a	A,B	—	42	63	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	—	—
Mn-Cr-Cu-V	—	—	Plate, Bar	A588-77a	A,B	—	46	67	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	—	—
Mn-Ni-Cr-Cu-V	—	—	Plate, Bar, Shapes	A588-77a	A,B	—	50	70	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	—	—
	—	—	Forging	SA-592	A,E,F	—	100	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	112.6	—	—
	—	—	Forging	SA-592	A,E,F	—	90	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	102.8	—	—
Mn-Cu-V	—	—	Tube	A618-74	II	—	50	70	70.0	70.0	70.0	70.0	70.0	70.0	70.0	69.3	—	—
Mn-V	—	—	Tube	A618-74	III	—	50	65	65.0	65.0	65.0	65.0	65.0	65.0	65.0	64.4	—	—
	—	—	Plate	A633-75	A	—	42	63	63.0	63.0	63.0	63.0	63.0	63.0	63.0	62.4	—	—
	—	—	Plate	A633-75	B	—	42	63	63.0	63.0	63.0	63.0	63.0	63.0	63.0	62.4	—	—
	—	—	Plate	A633-75	C,D	—	50	70	70.0	70.0	70.0	70.0	70.0	70.0	70.0	69.3	—	—
	—	—	Plate	A633-75	C,D	—	46	60	60.0	60.0	60.0	60.0	60.0	60.0	60.0	58.4	—	—
AISI 4140, 4340, 8620	—	—	Forging	A668-72	K	—	80	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	—	—
	—	—	Forging	A668-72	K	—	75	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	—	—
AISI 4140, 4340	—	—	Forging	A668-72	L	—	105	125	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	—	—
	—	—	Forging	A668-72	L	—	95	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	—	—
			Forging	A668-72	L	—	85	110	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	—	—
AISI 4330, 4340	—	—	Forging	A668-72	M	—	120	145	145.0	145.0	145.0	145.0	145.0	145.0	145.0	145.0	—	—
	—	—	Forging	A668-72	M	—	115	140	140.0	140.0	140.0	140.0	140.0	140.0	140.0	140.0	—	—
	—	—	Forging	A668-72	M	—	110	135	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	—	—

TABLE 5 (Cont'd)

Ultimate Tensile Stress Values, S_u, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
AISI 4340	—	—	Forging	A668-72	N	—	140	170	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	—	—
			Forging	A668-72	N	—	135	165	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	—	—
			Forging	A668-72	N	—	130	160	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	—	—
High Alloy Steels																		
Precipitation Hardened Steels																		
17Cr-1Ni-1Cu	—	—	Bar, Forg.	SA-564	630	—	105	135	135.0	135.0	135.0	131.4	128.5	126.7	125.6	124.4	120.8	118.1
17Cr-1Ni-1Cu	—	—	Bar, Forg.	SA-564	630	—	115	140	140.0	140.0	140.0	136.3	133.2	131.4	130.3	129.1	126.3	122.4
17Cr-1Ni-1Cu	—	—	Bar, Forg.	SA-564	630	—	125	145	145.0	145.0	145.0	141.1	140.0	136.1	134.9	133.7	130.8	126.8
13Cr-1Ni-1Cu	—	—	Bar, Forg.	A564-74	XM12	—	145	155	155.0	155.0	155.0	150.0	145.4	141.5	139.3	136.7	—	—
15Cr-4Ni-4Cu	—	—	Bar, Forg.	A564-74	XM12	—	125	145	145.0	145.0	145.0	140.4	136.1	132.4	130.3	127.9	—	—
13Cr-8Ni-2Cu	—	—	Bar, Forg.	A564-74	XM13	—	165	175	175.0	175.0	175.0	174.8	169.4	164.6	161.3	156.9	—	—
Stainless Steels																		
AISI 302, 304, 316, 317	—	—	Wire	A580-76	B	—	100	125	125.0	118.3	110.0	107.3	—	—	—	—	—	—
Bolting Materials																		
Carbon Steels																		
	—	—	—	SA-194	2H				105.0	105.0	105.0	105.0	—	—	—	—	—	—
	—	—	—	A307-76b	A	—	36	58	58.0	58.0	58.0	58.0	—	—	—	—	—	—
	1	1	—	SA-307	—													
	—	—	—	SA-325	—	—	81	105	105.0	105.0	105.0	105.0	—	—	—	—	—	—
Low Alloy Steels																		
AISI 4037, 4137, 4140	—	—	—	SA-320	L7A	<2½	105	125	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	—	—
	—	—	—	SA-320	L7B	<2½	105	125										
AISI 4037, 4140, 4340	—	—	—	A354-66	BB	<2½	83	105	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	—	—
AISI 4037, 4340	—	—	—	A354-66	BB	>2½<4	78	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	—	—
AISI 4037, 4340	—	—	—	SA-354	BC	<2½	109	125	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	—	—
AISI 4037, 4340	—	—	—	SA-354	BC	>2½<4	99	115	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	—	—
AISI 4037, 4340	—	—	—	SA-354	BD	<1½	125	150	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	—	—
AISI 1030, 1035, 1040, 1045, 1050	—	—	—	SA-449	—	≤ 1 in	85	125	125.0	125.0	125.0	125.0	—	—	—	—	—	—
	—	—	—	SA-449	—	>1≤1½	74	105	105.0	105.0	105.0	105.0	—	—	—	—	—	—
				SA-449	—	1¾ to 3	55	90	90.0	90.0	90.0	90.0	—	—	—	—	—	—
AISI 4135, 4140, 4340	—	—	—	A490-76a	—	—	130	150	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	—	—
AISI 1040, 4140, 4340	—	—	—	A574-76	—	—	135	170	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	—	—

TABLE 5 (Cont'd)

Ultimate Tensile Stress Values, S_U, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports, Class 1 Plate and Shell Type Component Supports, and for Bolting Materials for Classes 1, 2, 3, and MC Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Min Yield Strength, ksi	Min Ultimate Tensile Strength, ksi	Tensile Strength ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
Austenitic Stainless Steels																		
AISI 304	8	1	–	SA-193	B8	1	30	75	75.0	71.0	66.0	64.4	63.5	63.5	63.5	63.5	63.1	62.7
AISI 304	8	1	–	SA-193	B8A	1A												
AISI 347	8	1	–	SA-193	B8C	1	30	75	75.0	71.8	66.0	61.9	60.2	59.4	59.0	58.6	58.6	58.6
AISI 347	8	1	–	SA-193	B8CA	1A												
AISI 316	8	1	–	SA-193	B8M	1	30	75	75.0	75.0	73.4	71.8	71.8	71.8	71.8	71.8	71.4	71.0
AISI 316	8	1	–	SA-193	B8MA	1A												
AISI 321	8	1	–	SA-193	B8T	1	30	75	75.0	73.4	69.3	68.5	68.5	68.5	68.5	68.5	68.5	68.5
AISI 321	8	1	–	SA-193	B8TA	1A												
AISI 304	8	1	–	SA-194	B8	–	–	–	75.0	71.0	66.0	64.4	63.5	63.5	63.5	63.5	63.1	62.7
AISI 347	8	1	–	SA-194	B8C	–	–	–	75.0	71.8	66.0	61.9	60.2	59.4	59.0	58.6	58.6	58.6
AISI 316	8	1	–	SA-194	B8M	–	–	–	75.0	75.0	73.4	71.8	71.8	71.8	71.8	71.8	71.4	71.0
AISI 321	8	1	–	SA-194	B8T	–	–	–	75.0	73.4	69.3	68.5	68.5	68.5	68.5	68.5	68.5	68.5
AISI 304	8	1	–	SA-320	B8	–	30	75	75.0	71.0	66.0	64.4	63.5	63.5	63.5	63.5	63.1	62.7
AISI 347	8	1	–	SA-320	B8C	–	30	75	75.0	71.8	66.0	61.9	60.2	59.4	59.0	58.6	58.6	58.6
AISI 321	8	1	–	SA-320	B8T	–	30	75	75.0	73.4	69.3	68.5	68.5	68.5	68.5	68.5	68.5	68.5
AISI 303	8	1	–	SA-320	B8F	–	30	75	75.0	75.0	73.4	71.8	71.8	71.8	71.8	71.8	71.4	71.0
AISI 316	8	1	–	SA-320	B8M	–	30	75	75.0	75.0	73.4	71.8	71.8	71.8	71.8	71.8	71.4	71.0