



Designation: A400 – 23

Standard Practice for Steel Bars, Selection Guide, Composition, and Mechanical Properties¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice covers the selection of steel bars according to section and to the mechanical properties desired in the part to be produced. This is not a specification for the procurement of steel. Applicable procurement specifications are listed in Section 6.

1.2 Several steel compositions intended for various sections and mechanical property requirements are presented in **Tables 1-6**. The criteria for placing a steel composition in one of the three general class designations, Classes P, Q, and R (described in Section 5) are as follows:

1.2.1 *Classes P and Q* should be capable of developing the mechanical properties shown in **Tables 1-4** by liquid quenching from a suitable austenitizing temperature, and tempering at 800 °F (427 °C) or higher. A hardness indicated by tests made at a location shown in **Fig. 1**, A, B, or C, is taken as evidence that a composition is capable of meeting other equivalent mechanical properties shown in the tables. Normal good shop practices are assumed, with control of austenitizing and tempering temperatures, and mild agitation of the part in the quenching bath.

1.2.2 *Class R* should be capable of developing the mechanical properties shown in **Tables 5 and 6** as hot rolled, by cold drawing, or by cold drawing with additional thermal treatment. The locations for obtaining tension tests are described in **7.2**.

1.3 It is not implied that the compositions listed in the tables are the only ones satisfactory for a certain class and mechanical property requirement. Steels with lower alloy contents are often satisfactory through the use of special processing techniques.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

¹ This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.15 on Bars.

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

2. Referenced Documents

2.1 ASTM Standards:²

A108 Specification for Steel Bar, Carbon and Alloy, Cold-Finished

A304 Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements

A311/A311M Specification for Cold-Drawn, Stress-Relieved Carbon Steel Bars Subject to Mechanical Property Requirements

A322 Specification for Steel Bars, Alloy, Standard Grades
A633/A633M Specification for Normalized High-Strength Low-Alloy Structural Steel Plates

A675/A675M Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, refer to Terminology **A941**.

4. Significance and Use

4.1 If the desired mechanical properties are as described in **5.1.1** for material identified as Classes P-1 through P-7, or in **5.1.2** for material identified as Classes Q-1 through Q-7, the strength level desired can be based on hardness or the equivalent tensile or yield strength as shown in **Tables 1-4**. If the desired mechanical properties are as set forth in **5.1.3** for

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Steels for Moderately Quenched Parts—Classes P-1 Through P-7
(Applicable to oil-quenching or equivalent rate of heat-removal.)

NOTE 1—Steels listed as approved for a certain section or strength may be used for lighter sections and lower strengths.

NOTE 2—Steel composition numbers correspond to SAE or ASTM designations. Those in italics are no longer considered standard grades due to decreased usage.

NOTE 3—An H-steel with the same grade designation as a standard SAE steel is capable of meeting the same section and strength requirements as the standard steel (see Specification [A304](#)), and is the preferred method of specification.

NOTE 4—Steels having a maximum carbon content of 0.40 % or over, or a hardness of HB 293 or over after heat-treating, are not recommended for applications involving welding.

Desired Minimum Hardness Equivalent Tensile Strength, psi ^A Equivalent Yield Strength, psi ^A Minimum ^B As-Quenched Hardness						Class						
						P-1	P-2	P-3	P-4	P-5	P-6	P-7
						Diameter of Round (or Distance Between Faces of Square or Hexagonal) Sections, in. ^C						
						To ½, incl	Over ½ to 1, incl	Over 1 to 1½, incl	Over 1½ to 2, incl	Over 2 to 2½, incl	Over 2½ to 3, incl	Over 3 to 3½, incl
						Thickness of Flat Sections, in. ^C						
HB	HRC			HB	HRC	To 0.3, incl	Over 0.3 to 0.6, incl	Over 0.6 to 1, incl	Over 1 to 1.3, incl	Over 1.3 to 1.6, incl	Over 1.6 to 2.0, incl	Over 2.0 to 2.3, incl
229 to 293, incl	20 to 33, incl	110 000 to 145 000, incl	90 000 to 125 000, incl	388	42	1330 4130 5132 8630	50B30					
Over 293 to 341, incl	Over 33 to 38, incl	Over 145 000 to 170 000, incl	Over 125 000 to 150 000, incl	409	44	1335 3135 4042 5135	94B30	3140 4135 4640 8640 8740	4137	4142	9840	4337
Over 341 to 388, incl	Over 38 to 42, incl	Over 170 000 to 190 000, incl	Over 150 000 to 170 000, incl	455	48	1340 3140 4047 4135 5140 8637 TS14B50 50B40		4137 6145 8642 8645 8742	4140 TS4140 94B40	4145 9840	4147 4337 86B45	4340
Over 388 to 429, incl	Over 42 to 45, incl	Over 190 000 to 205 000, incl	Over 170 000 to 185 000, incl	496	51	1345 4063 4068 4140 4640 5145 5150 8640 8642	8645 8740 8742 9260 9261 TS4140 50B46 50B44 50B50	5147 5155 5160 6150 9262	4142 4145 4337 8650 8655 50B60 51B60 81B45	8660 9840	4147 4161 4340 86B45	4150 4161 TS4150 9850

^A 1 psi = 0.006895 MPa.

^B Minimum as-quenched hardness for obtaining desired hardness after tempering at 800 °F (427 °C) or higher.

^C 1 in. = 25.4 mm.

material identified as Classes R-1 through R-6, the strength level is based on yield strength as shown in [Tables 5 and 6](#).

4.2 The user, after determining the mechanical property requirements of the critical section (that carrying the greatest stress) of the part, should select the composition or compositions from [Tables 1-6](#) that fulfills these requirements and is most suitable for processing.

5. Classification

5.1 Steel bar compositions under this practice are classified according to mechanical property requirements and the critical section size of the part to be produced, as follows:

5.1.1 *Classes P-1 through P-7* comprise bars for parts to operate under severe service conditions requiring high yield strength (90 000 psi (621 MPa) and over), good ductility, and relatively high notch toughness. The applicable section sizes,

identified as Classes P-1 through P-7, are shown in [Table 7](#). The steel compositions suitable for Classes P-1 through P-7 and for various desired mechanical properties are listed in [Tables 1 and 2](#).

5.1.2 *Classes Q-1 through Q-7* comprise bars for parts operating under moderate service conditions requiring moderate to high yield strength (75 000 psi to 185 000 psi (517 MPa to 1276 MPa)), corresponding tensile-strength levels, and good ductility. The applicable section sizes, identified as Classes Q-1 through Q-7, are shown in [Table 7](#). The steel compositions suitable for Classes Q-1 through Q-7 and various desired mechanical properties are listed in [Tables 3 and 4](#).

5.1.3 *Classes R-1 through R-6* comprise bars for parts requiring a lower yield strength (30 000 psi to 120 000 psi (207 MPa to 827 MPa)), with fair to good ductility. The applicable section sizes, identified as Classes R-1 through R-6,