



Designation: **A400 – 69 (Reapproved 2012) A400 – 17**

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

This standard is issued under the fixed designation A400; 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 standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope-~~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 5.

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 4) 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) 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 **6.2**.

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.

1.5 *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

3. Significance and Use

3.1 If the desired mechanical properties are as described in **4.1.1** for material identified as Classes P-1 through P-7, or in **4.1.2** for material identified as Classes Q-1 through Q-7, the strength level desired can be based on hardness or the equivalent tensile

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.

Current edition approved March 1, 2012; Nov. 1, 2017. Published April 2012; December 2017. Originally approved in 1956. Last previous edition approved in 2006; 2012 as A400 – 69 (2012). (2006). DOI: 10.1520/A0400-69R12; 10.1520/A0400-17.

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

*A Summary of Changes section appears at the end of this standard

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, AISI, 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-AISI-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	229 to 293, incl	20 to 33, incl	110 000 to 145 000, incl	90 000 to 125 000, incl	388	42	1330	4130	50B30	50B30	
5132	8630			409	44	1335	94B30	3140	4137	409	4142	9840	4337	3140	4137		
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	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	94B30	3140	4137		
8740	8740			455	48	1340	4137	4140	4145	4147	4340	4137	4140	4137	4140		
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	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	4137	4140	4137	4140	
50B40	50B40			496	51	1345	8645	5147	4142	8660	4147	4150	E4340	8645	5147	4142	
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	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	8645	5147	4142		
8642	50B50			5150	54	4063	8740	5155	4145	4068	8742	5160	4337	4140	9260	6150	8650
				4640	50	4640	9261	9262	8655	5145	TS4140	50B60	5150	50B46	94B40	51B60	
				8640	50	8640	50B44	81B45									

^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.

or yield strength as shown in Tables 1-4. If the desired mechanical properties are as set forth in 4.1.3 for material identified as Classes R-1 through R-6, the strength level is based on yield strength as shown in Tables 5 and 6.

3.2 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 fulfill these requirements and is most suitable for processing.

4. Classification

4.1 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:

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

TABLE 2 Steels for Drastically Quenched Parts—Classes P-1 Through P-7
(Applicable to water-quenching or equivalent rate of heat-removal — See Note 5)

NOTE 1—Steels listed as approved for heavier sections or higher strengths may be used in the same conditions for lighter sections and lower strengths.

NOTE 2—Steel composition numbers correspond to *ASE*, *AISI*, *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-AISI-~~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.

NOTE 5—Parts made of steel with a carbon content of 0.33 % or higher, where the section is under 1½ in. (38.1 mm) should not be quenched in water without careful exploration for quench-cracking.

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								
HB	HRC			HB	HRC	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 1.0, incl	Over 1.0 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	8625 229 to 293, —incl	4130 20 to 33, —incl	94B30 110 000 to 145 000, —incl	90 000 to 125 000, —incl	388	42	8625 8627	4130 5130 8630	94B3
<i>50B30</i>														
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	4032 Over 293 to 341, —incl	4330 Over 33 to 38, —incl	4335 Over 145 to 170 000, —incl	— 125 000 to 150 000, —incl	1340 ^D 409 3135 ^D 4640	3140 44	4137 4032 4130 9840 5130 8630 8740	1330 1335 5135 5140	50B4
<i>50B30</i>														
<i>TS14B35</i>														

^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.
^D These steels have insufficient hardenability for Class P-4, because of difference in test locations, but are satisfactory for other smaller 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**.

4.1.2 *Classes Q-1 through Q-7* comprise bars for parts operating under moderate service conditions requiring moderate to high yield strength (75 000 to 185 000 (75 000 to 185 000 psi (517 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**.

4.1.3 *Classes R-1 through R-6* comprise bars for parts requiring a lower yield strength (30 000 to 120 000 (30 000 to 120 000 psi (207 to 827 MPa)), with fair to good ductility. The applicable section sizes, identified as Classes R-1 through R-6, are shown in **Table 7**. The steel compositions capable of developing the various desired mechanical properties are listed in **Tables 5 and 6**.

5. Applicable Procurement Specifications

5.1 For procurement of steel, it is recommended that the following ASTM specifications of latest issue be used: Specification **A108**, Specification **A304**, Specification **A311/A311M**, Specification **A322**, Specification **A633/A633M**, and Specification **A675/A675M**.

6. Location at Which Desired Properties Are Obtained

6.1 *Classes P-1 Through P-7 and Q-1 Through Q-7*—The mechanical properties shown in **Tables 1-4** are based on obtaining hardness test specimens from the locations shown in **Fig. 1**, A, B, and C. For bars, the location should be at least twice the diameter or minimum distance between faces from an end; and for flat sections, at least twice the thickness from an edge.

TABLE 3 Steels for Moderately Quenched Parts—Classes Q-1 Through Q-7
(Applicable to oil-quenching or equivalent rate of heat-removal.)

NOTE 1—Steels listed as approved for heavier sections or higher strengths may be used in the same conditions for lighter sections and lower strengths.

NOTE 2—Steel composition numbers correspond to *ASE*, *AISI*, *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-AISI-~~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								
					Diameter of Round (or Distance Between Faces of Square or Hexagonal) Sections, in. ^C								
					Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7		
					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 1.0, incl	Over 1.0 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	
187 to 293, —incl to 33, incl	91 (R _b), —to 33, to 33, —incl to 33, —incl	95 000 to 145 000, —incl to 145 000, —incl	75 000 to 125 000, —incl to 125 000, —incl	388	42	1330 8630 4130 50B30 4130 <u>50B30</u> 5132	8637	3140 8740 8740	TS4140	4140 94B40 94B40	4142		
Over 293 —to 341, to 341, —incl incl	Over 33 —to 38, to 38, —incl incl	Over 145 000 —to 170 000, —incl to 170 000, —incl incl	Over 125 000 —to 150 000, —incl to 150 000, —incl incl	409	44	1335 4042 50B30 4042 <u>50B30</u> 5135 5135 — 94B30 94B30	3140 8740 4135 4135 4640 4640 8640 8640	4137 4140 4140 8642 8642 8645 8645	TS4140	81B45 4142 4145	4145	4147 4337 4337 9840 9840 86B45 86B45	
Over 341 —to 388, to 388, —incl incl	Over 38 —to 42, to 42, —incl incl	Over 170 000 —to 190 000, —incl to 190 000, —incl incl	Over 150 000 —to 170 000, —incl to 170 000, —incl incl	455	48	1340 8637 3135 TS14B50 3135 <u>TS14B50</u> 3140 50B40 3140 <u>50B40</u> 4047 4135 4135 5140	1345 8742 4137 TS4140 4137 <u>TS4140</u> 4140 50B50 4140 <u>50B50</u> 5150 8642 8642 8645	4142 5147 5147 5155 5155 6150 6150	94B40	51B60	4145 8655 8655 9840 9840 86B45 86B45	4147 4340 4340 TS4150 TS4150 86B45 86B45	4150 4340 4340 TS4150 TS4150
Over 388 —to 429, to 429, —incl incl	Over 42 —to 45, to 45, —incl incl	Over 190 000 —to 205 000, —incl to 205 000, —incl incl	Over 170 000 —to 185 000, —incl to 185 000, —incl incl	496	51	1345 8645 4047 8740 4047 8740 4063 8742 4063 <u>8742</u> 4068 9260 4140 TS4140 4140 <u>TS4140</u> 4640 50B46 5145 50B44 5150 50B50 8640 8642	4142 5147 5147 5155 5160 6150 9261 9261 9262	4145 4337 4337 5160 5160 8650 8655 8655 9262	9840	4147 4340 4340 8660 8660 86B45	4150 TS4150 TS4150 8660 8660 86B45	E4340 9850 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.

6.2 *Classes R-1 Through R-6*—The mechanical properties shown in **Tables 5 and 6** are based on obtaining tension test specimens from the following locations:

6.2.1 Center of bars or plates under 1½ in. (38.1 mm) in diameter or in distance between parallel surfaces, and

6.2.2 Mid-radius or a quarter of the distance between parallel faces from the surface for larger sections.