



# Chapter 48

## Stainless Steels in Fasteners

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### INTRODUCTION

An analysis of standard fasteners, such as bolts and screws, reveals that all have certain characteristics in common. Further, their differences can be classified as shown in Fig. 1. Thus, the fasteners may have some or all of these parts: head, driving recess, shoulder, unthreaded shank, threaded shank, and point. Certain combinations of these components, because of usage, are considered standard. Others are nonstandard, but nearly any combination can readily be produced.

**Basic Considerations** In modern fastening technology, the object is to reduce the friction between the nut and the bolt, or the mating parts. The ideal fastening condition is obtained when the nut is driven on the bolt, or the bolt into the mating part, without friction and up to the bolt's elastic limit. It is not necessary that the bolt shank fit deadtight into the clearance hole if the proper tension is placed on the fastener, since the fastener should rely on tension, rather than its fit, for holding power.

Some general rules of good fastening technique are:

1. Use a larger number of fasteners of small diameter, rather than fewer large diameter fasteners.
2. Use fasteners with as near frictionless threads as possible. Fastener threads must be clean of dirt. Machine screws, bolts, and nuts should be lubricated.
3. Use a definite torque in driving the fastener to a certain percentage of the fastener's elastic limit. Examples of suggested maximum torquing values for 18-8 and Type 316 stainless steels are shown in Table 1. Note that the table refers to "18-8." This term encompasses Types 302, 303, 304, and 305, depending on whether the fastener is hot-formed, cold-headed, or machined.

**Thread Forms** The modern Unified and American Standard screw thread has evolved from threaded parts used by clockmakers and gunsmiths of the seventeenth and eighteenth centuries. Three principal systems of screw threads gradually developed around the world: the Unified and American Standard Form, the British Whitworth Form, and the European Metric Form. These are discussed in detail below. It is interesting to note, however, that certain thread forms exist which are peculiar to certain industries. Many water meters have their own thread standards, just as they did

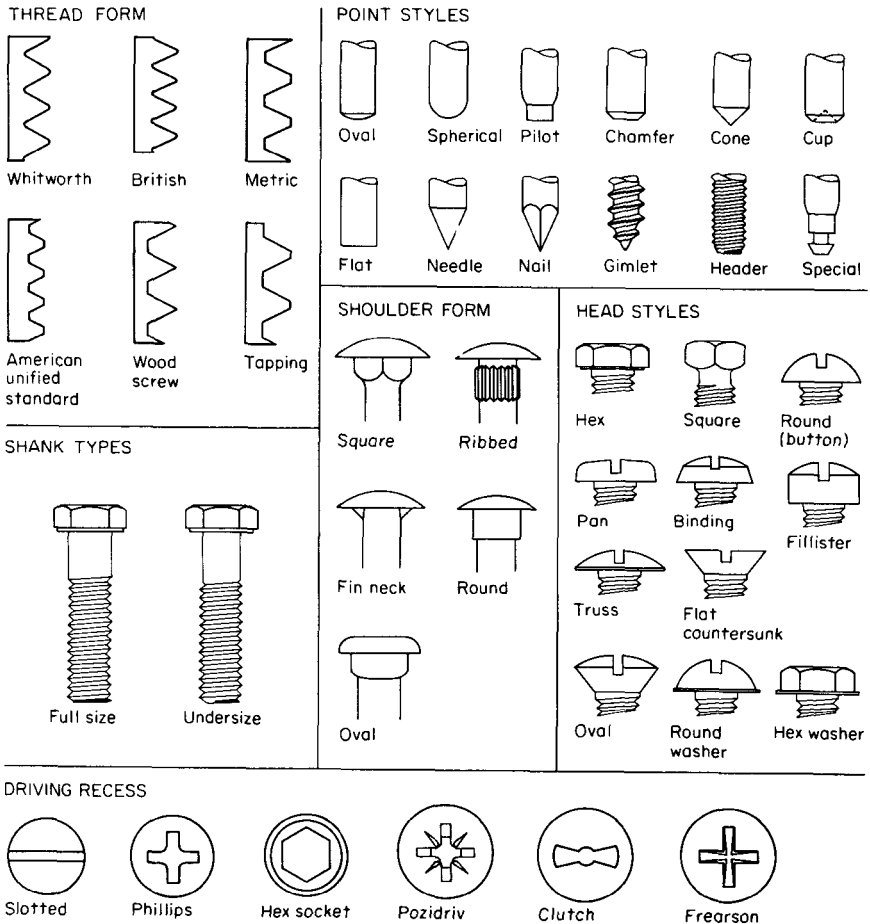


Fig. 1 General characteristics of fasteners.

TABLE 1 Suggested Maximum Torquing Values for Stainless Steel Bolts\*

Bolt size	18-8	Type 316
VALUES ARE STATED IN IN.-LB (J)		
2-56	2.5 (0.28)	2.6 (0.29)
2-64	3.0 (0.34)	3.2 (0.36)
3-48	3.9 (0.44)	4.0 (0.45)
3-56	4.4 (0.50)	4.6 (0.52)
4-40	5.2 (0.59)	5.5 (0.62)
4-48	6.6 (0.75)	6.9 (0.78)
5-40	7.7 (0.87)	8.1 (0.92)
5-44	9.4 (1.06)	9.8 (1.11)
6-32	9.6 (1.08)	10.1 (1.14)
6-40	12.1 (1.37)	12.7 (1.44)
8-32	19.8 (2.24)	20.7 (2.34)
8-36	22.0 (2.49)	23.0 (2.60)
10-24	22.8 (2.58)	23.8 (2.69)
10-32	31.7 (3.58)	33.1 (3.74)
1/4"-20	75.2 (8.50)	78.8 (8.90)
1/4"-28	94.0 (10.62)	99.0 (11.19)
5/16"-18	132 (14.92)	138 (15.59)
5/16"-24	142 (16.05)	147 (16.61)
3/8"-16	236 (26.67)	247 (27.91)
3/8"-24	259 (29.27)	271 (30.62)
7/16"-14	376 (42.49)	393 (44.41)
7/16"-20	400 (45.20)	418 (47.23)
1/2"-13	517 (58.42)	542 (61.25)
1/2"-20	541 (61.13)	565 (63.85)
5/8"-12	682 (77.07)	713 (80.57)
5/8"-18	752 (84.98)	787 (88.93)
3/4"-11	1110 (125.43)	1160 (131.08)
3/4"-18	1244 (140.57)	1301 (147.01)
7/8"-10	1530 (172.89)	1582 (178.77)
7/8"-16	1490 (168.37)	1558 (176.05)
7/8"-9	2328 (263.06)	2430 (274.59)
7/8"-14	2318 (261.93)	2420 (273.46)
1"-8	3440 (388.72)	3595 (406.24)
1"-14	3110 (351.43)	3250 (367.25)
VALUES ARE STATED IN FT.-LB (J)		
1 1/8"-7	413 (560.03)	432 (585.79)
1 1/8"-12	390 (528.84)	408 (553.25)
1 1/4"-7	523 (709.19)	546 (740.38)
1 1/4"-12	480 (650.88)	504 (683.42)
1 1/2"-6	888 (1204.13)	930 (1261.08)
1 1/2"-12	703 (2157.4)	732 (992.59)

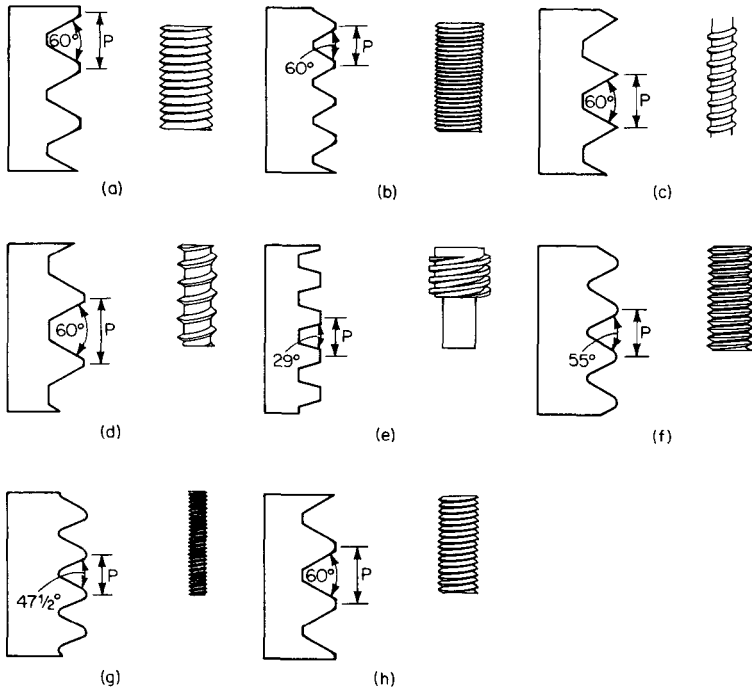
\*Based on dry product wiped clean.

80 years ago. And, many gas fixtures have their specialized thread forms, including left-handed leads, to prevent the uninitiated from installing unsafe fittings in gas lines.

The fine thread series of the Unified and American Standard, as distinct from the coarse thread series, came into existence years ago through the efforts of the Society of Automotive Engineers. It was felt that more threads per inch permitted better wrenching because

of the smaller helix angle. Although some of the advantages claimed for fine threads have been disproved, they still have great popularity in certain industries.

**Unified Thread Form.** This form encompasses both the Unified Coarse Thread UNC (Fig. 2a) and the Unified Fine Thread UNF (Fig. 2b). It is used for most of the bolts, nuts, screws, and other threaded products made in the United States and Canada. The fine thread series is distinguished from the coarse by the greater number of threads per inch



**Fig. 2** Thread forms. (a) Unified coarse thread, UNC. (b) Unified fine thread, UNF. (c) American Standard Wood Screw. (d) American Standard Tapping Screw. (e) American Standard Acme. (f) British Standard Whitworth. (g) British Association Standard. (h) European Metric.

applied to a specific diameter. It is recommended for general use in automotive and aircraft work where wall thickness requires a fine thread.

**American Standard Thread Form.** Three forms are contained within this group:

1. **American Standard Wood Screw Thread.** Interchangeability of parts is not a prerequisite for wood screw thread forms since the threads cut into the workpiece and do not mate with tapped holes. The form illustrated in Fig. 2c is in accordance with American Standard B18.6.1-1961.

2. **American Standard Tapping Screw Thread.** Interchangeability is not a requirement for tapping screw thread forms. The form shown in Fig. 2d meets American Standard B18.6.4-1966.

3. **American Standard Acme Thread.** This thread form is used chiefly for producing traversing motions. American Standard B1.5-1952 standardized acme threads into two classes: (1) general purpose with clearance on all diameters for free movement and (2) centralizing threads, with more limited clearance at the major diameter between external and internal threads (Fig. 2e).

**British Thread Form.** Two forms are described:

1. **British Standard Whitworth Thread.** The crest and root of this thread form are rounded. The form is in general use in the United Kingdom. This thread form is also used in the British Standard Fine Screw Threads (BSF), British Standard Pipe Threads (BSP), and British Standard Conduit Threads (BSC) (see Fig. 2f).

2. *British Association Standard Thread.* This screw thread system (Fig. 2g) is recommended by the British Standards Institution for use in preference to the BSW and BSF systems for all screws smaller than  $\frac{1}{4}$  in. (6.35 mm).

*European Metric Thread Form.* This thread form is similar to the Unified American Standard except the depth of the thread is greater. This system has been adopted by most European countries using the metric system, by Japan, and by the Soviet Union, either in whole or in part (Fig. 2h).

**Mechanical Property Requirements** Minimum mechanical property requirements for a range of stainless steel fasteners are described in Table 2, based on Industrial Fasteners Institute Standard 104. The data, intended for use in industrial engineering applications, are based on tests of full-sized fasteners. Testing the fastener, rather than the material from which it is formed, gives the designer an advantage because higher strengths generally can be used in design considerations. Lack of this product information in the past often led to over-design.

## INDUSTRIAL APPLICATIONS OF FASTENERS

Fasteners are ubiquitous. Because of their very broad use, only four major industries will be examined.

**Chemical Process Industries** Since corrosion resistance is an important aspect of product reliability, the careful selection of fasteners is inherent in any attempt to achieve corrosion-resistant assemblies. An excellent and conservative practice in this industry is to use fasteners made of alloys that are actually more corrosion-resistant than the materials they hold together. This practice is often desirable because corrosion-weakened fasteners may lead to a more immediate failure, with more serious consequences, than the same amount of corrosive attack elsewhere in the assembly.

*Fluid Flow.* Pumps used in the chemical process industries embrace a large variety of types and sizes. Fastening requirements vary with the pump type. Bolts, nuts, studs, screws, and washers are used, for example, to connect the pump to its bearing frame, to attach piping to the pump, and to assemble the stuffing box. Here, the corrosive nature of the liquid being pumped, the atmosphere in which the pump is located, and the possibility of galvanic attack require care in the selection of a fastener material. Choices often made include 18-8, Type 410, and Carpenter 20. Pipe and fittings present similar problems of attachment and are fastened in much the same manner as pumps and valves. The fastener must resist the corrosive environment in which the equipment is located. Fasteners for valves should be fabricated from the same material as the valve or from a more noble metal. Examples of applications include assembling the yoke to the body, attaching valve bodies to bonnets, attaching handwheels, etc.

*Size Reduction and Enlargement.* While most crushing and grinding equipment is made of steel, special requirements, such as the size reduction of corrosive material may lead to the use of other metals. Generally, the fasteners used will be similar in composition to the parts being joined. But, at times, stainless steel bolting is used even with a carbon steel assembly, especially where the assembly must be taken apart periodically. Cutters, shredders, chippers, and dicers perform variations of crushing and grinding and are subject to the same problems and requirements.

*Mixing and Blending.* Typical examples of fastener use in this area include hex head bolts with nuts and lock washers for the paddle blades. Stainless steel is often specified because of its strength, hardness, and corrosion resistance.

Stainless steel fasteners are also used in areas such as fractionation, distillation, heat transfer, separation, and filtration. Equipment is subjected to a corrosive environment, requiring a careful selection of fasteners.

*Maintenance.* Maintenance is the key to efficient, uninterrupted production. The use of corrosion-resistant fasteners can delay maintenance needs and can speed up disassembly for inspection.

**Marine Industry** Very often, the fastenings on ships and boats are used where the joints have to be taken apart and reassembled from time to time. This is when the corrosion resistance of the fastener assumes its greatest economic advantage. One factor that must always be kept in mind in dealing with various metal combinations in seawater is galvanic corrosion. As a general rule, the fastener alloy, if it is not the same as the material being joined, should be lower in the galvanic series (more noble) than the material being joined.

TABLE 2 Mechanical Requirements for Stainless Steel Fasteners

Grade*	Bolts, screws and studs										Nuts
	Full-size bolts, screws, studs					Machined test specimens of bolts, screws, studs					
	General description of material	Yield strength, min., psi (MN/m <sup>2</sup> )	Tensile strength, min., psi (MN/m <sup>2</sup> )	Yield† strength, min., psi (MN/m <sup>2</sup> )	Tensile strength, min., psi (MN/m <sup>2</sup> )	Elongation, † %, min.	Hardness Rockwell, min.	Hardness Rockwell, min.	Proof load stress, psi (MN/m <sup>2</sup> )		
303-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B75	B75	75,000 (517.13)	B75	
304-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B75	B75	75,000 (517.13)	B75	
304	Austenitic stainless steel, cold-worked	50,000 (344.75)	90,000 (620.55)	45,000 (310.28)	85,000 (586.08)	20	B85	B85	90,000 (620.55)	B85	
304-SH	Austenitic stainless steel, strain hardened	See Note‡	See Note‡	See Note‡	See Note‡	15	C25	C20	See Note‡	C20	
305-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B70	B70	75,000 (517.13)	B70	
305	Austenitic stainless steel, cold-worked	50,000 (344.75)	90,000 (620.55)	45,000 (310.28)	85,000 (586.08)	20	B85	B85	90,000 (620.55)	B85	
305-SH	Austenitic stainless steel, strain hardened	See Note‡	See Note‡	See Note‡	See Note‡	15	C25	C20	See Note‡	C20	
316-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B70	B70	75,000 (517.13)	B70	

316	Austenitic stainless steel, cold-worked	50,000 (344.75)	90,000 (620.55)	45,000 (310.28)	85,000 (586.08)	20	B85	90,000 (620.55)	B85	C20
316-SH	Austenitic stainless steel, strain hardened	See Note§	See Note§	See Note§	See Note§	15	C25	See Note§		
XM7-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B70	75,000 (517.13)	B70	B70
XM7	Austenitic stainless steel, cold-worked	50,000 (344.75)	90,000 (620.55)	45,000 (310.28)	85,000 (586.08)	20	B85	90,000 (620.55)	B85	B85
384-A	Austenitic stainless steel, solution annealed	30,000 (206.85)	75,000 (517.13)	30,000 (206.85)	75,000 (517.13)	20	B70	75,000 (517.13)	B70	B70
384	Austenitic stainless steel, cold-worked	50,000 (344.75)	90,000 (620.55)	45,000 (310.28)	85,000 (586.08)	20	B85	90,000 (620.55)	B85	B85
410-H	Martensitic stainless steel, hardened and tempered	95,000 (655.03)	125,000 (861.88)	95,000 (655.03)	125,000 (861.88)	20	C22	125,000 (861.88)	C22	C22
410-HT	Martensitic stainless steel, hardened and tempered	135,000 (930.83)	180,000 (1241.10)	135,000 (930.83)	180,000 (1241.10)	12	C36	180,000 (1241.10)	C36	C36
416-H	Martensitic stainless steel, hardened and tempered	95,000 (655.03)	125,000 (861.88)	95,000 (655.03)	125,000 (861.88)	20	C22	125,000 (861.88)	C22	C22
416-HT	Martensitic stainless steel, hardened and tempered	135,000 (930.83)	180,000 (1241.10)	135,000 (930.83)	180,000 (1241.10)	12	C36	180,000 (1241.10)	C36	C36

**TABLE 2 Mechanical Requirements for Stainless Steel Fasteners (Continued)**

430	Ferritic stainless steel	40,000 (275.80)		70,000 (482.65)		40,000 (275.80)		70,000 (482.65)		20		B75		70,000 (482.65)		B75	
		40,000 (275.80)		70,000 (482.65)		40,000 (275.80)		70,000 (482.65)		20		B75		70,000 (482.65)		B75	
<p>*Grade designations: A, solution annealed; SH, strain hardened; H, hardened and tempered at 1100°F (593°C) min.; HT, hardened and tempered at 525°F ± 50°F (274°C ± 28°C); HF, hot-forged. †At 0.2% offset.                  ‡In 2 in. (50.8 mm) or 4 diameters.                  §Strain-hardened austenitic stainless steel bolts, screws, studs, and nuts shall have the following mechanical properties:</p>																	
Bolts, screws, studs																	
		Tested full size				Machined test specimens				Nuts							
		Yield strength, min., psi (MN/m <sup>2</sup> )		Tensile strength, min., psi (MN/m <sup>2</sup> )		Yield strength, min., psi (MN/m <sup>2</sup> )		Tensile strength, min., psi (MN/m <sup>2</sup> )		Proof load stress, psi (MN/m <sup>2</sup> )							
Product size, in. (mm)		100,000 (689.5)		125,000 (861.85)		90,000 (620.55)		115,000 (792.93)		125,000 (861.88)							
To ½ (15.88)																	
Over ¾ to 1 (15.88-25.4)		70,000 (482.65)		105,000 (723.98)		65,000 (448.18)		100,000 (689.5)		105,000 (723.98)							
Over 1 to 1½ (25.4-38.1)		50,000 (344.75)		90,000 (620.55)		45,000 (310.28)		85,000 (586.08)		90,000 (620.55)							

**Pulp and Paper Industry** This industry experiences severe corrosion problems because of the nature of its operations.

**Barking.** Hydraulic barking focuses high-pressure jet streams of water on the logs, encouraging steady corrosion of all components. Mechanical barking places high stress on critical areas and involves continuous maintenance and replacement. 18-8 or Type 316 fasteners are recommended.

**Pulping.** There are several approaches to pulping:

1. **Mechanical.** Logs are ground against a revolving abrasive stone. 18-8 fasteners are recommended.

2. **Sulfite.** All of the sulfite processes are highly corrosive. Recommended stainless fastenings are Types 316, 309, and Hastelloy C. These alloys are especially valuable for target plates in the blow pit and for all digester fittings.

For magnesia-based pulping, Type 316 and Hastelloy C are recommended.

3. **Semichemical.** The neutral sulfite, semichemical pulping employs a dilute acid solution in which Type 309 fasteners offer superior performance. Type 316 is also recommended.

4. **Alkaline.** Soda pulping and kraft or sulfate pulping are both alkaline processes. Fasteners associated with the digester dump valve and digester body should be of Type 316 or 18-8.

**Digesters, Diffusers, Vacuum Washers, Bleach Liquor Evaporators, and Pulp Screens.** The same type of stainless steel fastener recommended for the digester, 18-8 or Type 316, should also be used for the blow tanks, diffusers, brown stock washers, knotter screens, and fire screens. Nearby fasteners, such as motor mountings, are also subject to corrosion if not made of stainless steel.

**Pulp Bleaching.** When sodium chlorite or sodium peroxide are used in the bleaching process, Type 316 fasteners should be specified. That alloy is also recommended when hydrogen peroxide, zinc hydrosulfite, and calcium hypochlorite are used in the bleaching process.

**Stock Preparation.** Types 316 and 18-8 have proved to be superior fastener alloys. Stock chest fittings, agitators, beater bars, and pipe connections should also be fastened with these alloys.

**Fourdrinier and Cylinder Paper Machines.** Austenitic stainless steels and Monel are now used extensively for shower pipes, midfeathers, slices, aprons, headbox linings, save-all trays, and doctor blades. Fasteners of similar metal should be used for all these applications.

**Pollution Control Industry** Both water and air pollution control are receiving greater attention. Each area encounters problems that require the use of stainless steel fasteners.

**Water Pollution.** Components of water pollution control systems include:

1. **Filters.** Normally constructed of carbon steel, but stainless steel is being specified more frequently to reduce maintenance problems. Type 316 is the suggested fastener alloy. When carbon steel components require frequent disassembly, 18-8 is suggested.

2. **Adsorption Columns.** Type 18-8 fasteners are a good choice if the columns are specified in stainless steel, or to attach parts that require maintenance.

3. **Activated Sludge and Aerators.** Stainless steel fasteners, generally 18-8 or Type 316, are used to connect the aeration blades to the main driving hood. Bolts, nuts, and washers are used. Stainless steel locknuts are sometimes specified to prevent loosening due to vibration.

4. **Thermal Cooling Units.** Cooling towers are usually constructed either of prestressed concrete slabs or redwood sections. In the former, 18-8 or silicon bronze U bolts and nuts are used to support the pipes. In the redwood towers, each section is bolted together, most commonly with either Type 304 or naval bronze fasteners.

**Air Pollution.** In equipment such as dust collectors, fabric filters, and electrostatic precipitators, 18-8 is a preferred fastening material. More severe corrosion or oxidation conditions are encountered in wet scrubbers, afterburners, and adsorbers. The wet scrubbers can use Type 18-8 fasteners, but Type 316 or Carpenter 20 should be specified under extreme conditions of corrosion. Afterburners, operating at temperatures from 800 to 1600°F (426 to 871°C), require Types 309, 310, or 321 fasteners.

# Appendix 1

## Specifications of the Stainless Steel Producing Countries

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The material which follows this short introduction represents composition data obtained from the specifications of the various countries that produce stainless steel. Most of the data refer to wrought steels. When cast steels are described, that is indicated in the title of the table. In addition to the chemical compositions described in this Appendix, the reader is referred to Table 1, Chapter 1, which compares AISI grades with their approximate equivalents produced by other nations; and to two tables in Chapter 2: Table 7, which compares the equivalent specifications for corrosion-resistant cast steels; and Table 8, which makes the comparison for heat-resistant cast steels.

The tables which follow only note chemical composition. Details on mechanical properties, permissible length, width, and thickness variations, etc., the usual structure of a specification, can be obtained by consulting the actual specifications noted on each of the tables. Sources of the specifications are as follows:

CZECHOSLOVAKIA: FERROMET Foreign Trade Corp., P. O. Box 779, Prague 1

EUROPEAN ECONOMIC COMMUNITY: Commission des Communautés Europeennes, Rue de la Loi 200, B-1040 Brussels, Belgium

FRANCE: Chambre Syndicale des Producteurs D'Aciers Fins et Spéciaux, 12, rue de Madrid, Paris (VIIIe)

GERMANY, EAST: Council for Standardization, Berlin, DDR

GERMANY, WEST: Verein Deutscher Eisenhüttenleute, Breite Strasse 27, 4000 Düsseldorf 1

GREAT BRITAIN: British Standards Institution, British Standards House, 2 Park Street, London W1Y 4AA

HUNGARY: METALIMPEX, P. O. Box 330, Budapest 62

INDIA: Indian Standards Institution, 9 Bahadur Shah Zafar Marg, New Delhi 110001

**A1-2 Appendix 1**

ITALY: Centro Inox, piazza Velasca, 10, 20122 Milan

JAPAN: Japanese Standards Association, 1-24, Akasaka 4, Minate-ku, Tokyo 107

POLAND: Polski Komitet Normalizacji i Miar, ul. Elektoralna 2, 00-139 Warsaw

ROMANIA: METALIMPORTEEXPORT, 8 Edgar Quinet Street, Bucharest

SOVIET UNION: GOSSTANDART USSR, Department for Foreign Relations, Leninskiy Prospekt 96, Moscow M-49

SPAIN: CENIM, Ciudad Universitaria, Madrid 3

SWEDEN: Sveriges Standardiseringskommission, Box 3295, 103 66 Stockholm 3

UNITED STATES: American Iron and Steel Institute, 1000 16th Street N.W., Washington, D.C. 20036

EDITOR'S NOTE: The newly revised Austrian specification, "Steel Plates for Boilers and Pressure Vessels," issued 1 August 1976, was received too late to be included in the tables which follow. The specification, ONORM M3121, includes nineteen stainless steels within its ambit. Copies can be obtained from Österreichisches Normungsinstitut, Leopoldsgasse 4, A-1021 Vienna 2, Austria.

**CZECHOSLOVAKIA Stainless and Heat-resisting Steels**  
**Specification: Československá Státní Norma (CSN4)**

Standard number	Composition, %										Other elements
	C, max.	Mn, max.	P, max.	S, max.	Si, max.	Cr	Ni	Mo			
17020	0.08	0.90	0.040	0.035	0.70	12.0-14.0					
17021	0.15	0.90	0.040	0.035	0.70	12.0-14.0					
17022	0.16-0.25	0.90	0.040	0.035	0.70	12.0-14.0					
17023	0.26-0.35	0.90	0.040	0.035	0.70	12.0-14.0					
17024	0.36-0.45	0.90	0.040	0.035	0.70	12.0-14.0					
17027	0.15-0.25	0.90	0.040	0.035	0.70	14.0-16.0					
17029	0.40-0.50	0.90	0.040	0.035	0.70	14.0-16.0					Ti ≤ 0.30
17040	0.10	0.90	0.040	0.035	0.70	16.0-18.5	0.60 max.				Ti ≤ 0.30
17041	0.15	0.90	0.040	0.035	0.70	16.0-18.5	0.60 max.				
17042	0.90-1.05	0.90	0.040	0.035	0.70	16.0-18.0					
17047	0.15	0.80	0.045	0.035	0.80	20.0-23.0	0.60 max.				Ti ≤ 0.70
17061	0.18	0.80	0.045	0.035	0.80	23.0-26.0	0.60 max.				Ti ≤ 0.70
17062	0.16	0.60	0.040	0.035	0.50	23.0-26.0	0.60 max.				
17113	0.15	0.60	0.040	0.035	0.80-1.30	6.0-7.5					Al 0.40-1.00
17115	0.40-0.50	0.60	0.040	0.035	2.80-3.50	7.50-9.50					
17125	0.15	0.80	0.040	0.035	1.00-2.00	12.0-14.5					Al 0.60-1.20
17132	0.18-0.26	0.50-1.20	0.040	0.030	0.50	10.5-12.5	0.40 max.				V 0.20-0.60
17134	0.17-0.23	0.50-1.00	0.035	0.030	0.25-0.60	10.6-12.5	0.30-0.80	0.8-1.2			W 0.30-0.60 V 0.20-0.35
17153	0.20	1.00	0.045	0.040	1.30	23.0-27.0	2.0 max.				
17225	0.12	2.00	0.040	0.035	1.00	13.0-15.0	10.0-12.0				
17240*	0.08					18.5	10.0				

**CZECHOSLOVAKIA** Stainless and Heat-resisting Steels (Continued)  
 Specification: Československa Státní Norma (CSN4)

Standard number	Composition, %										Other elements
	C, max.	Mn, max.	P, max.	S, max.	Si, max.	Cr	Ni	Mo			
17241	0.12	2.00	0.045	0.030	1.00	17.0-20.0	8.0-11.0				
17242	0.25	2.00	0.045	0.030	1.00	17.0-20.0	8.0-11.0				
17246	0.12	2.00	0.045	0.030	1.00	17.0-20.0	8.0-11.0				Ti $\geq 5 \times (C - 0.03)$
17248*	0.10					18.0	10.5				
17249*	0.03					18.5	11.0				Ti $\geq 5 \times C$
17251	0.20	1.50	0.035	0.035	2.00	18.0-21.0	8.0-11.0				
17252	0.12	1.50	0.045	0.035	1.50	19.0-22.0	36.0-40.0	4.50-6.50			4 $\times C \leq Ti \leq 1.00$
17253	0.25	1.50	0.035	0.035	1.50	19.0-22.0	36.0-40.0				
17254	0.12	0.40-1.20	0.050	0.035	0.80	19.5-22.0	4.50-5.80				Ti 0.30-0.60
17255	0.25	1.50	0.045	0.030	2.00	23.0-27.0	18.0-22.0				
17331	0.07-0.15	0.40-1.00	0.045	0.030	0.20-0.80	12.0-15.0	11.0-14.0	0.70-1.50			W 1.00-2.00 V 0.30-0.80 Ti $\leq 1.00$

17335	0.12	1.00-2.00	0.045	0.030	0.80	13.5-16.5	34.0-38.0	W 2.70-3.70 Ti 1.20-1.90
17345	0.15	2.00	0.045	0.030	1.50	16.00-19.0	9.00-12.0	1.50-2.50
17346*	0.08					17.5	12.5	2.25
17347	0.12	2.00	0.045	0.030	1.50	16.0-19.0	9.00-12.0	1.50-2.50
17348*	0.10					17.5	12.5	2.25
17349*	0.03					17.5	12.5	2.25
17350*	0.03					17.5	13.5	2.75
17351	0.08	0.30-0.80	0.045	0.035	0.90	15.5-17.0	5.50-7.00	Al $\leq$ 1.00 Ti 0.50-1.00
17352*	0.08					17.5	12.5	2.75
17353*	0.10					17.5	13.5	2.75
17356*	0.08					17	14.5	3.5
17460	0.12	7.00-10.0	0.060	0.035	0.90	17.0-20.0	4.00-6.00	N 0.10-0.25
17471	0.05-0.12	14.0-17.0	0.045	0.035	0.60-1.50	16.0-19.0	1.20-2.00	N 0.32-0.42

\*Denotes average composition.

**EASTERN EUROPEAN ECONOMIC COMMUNITY Stainless and Heat-resisting Steels**  
**Specification: COMECON PC4-70**

Type	Composition, %										Other elements	
	C, max.	Mn, max.	P, max.	S, max.	Si, max.	Cr	Ni	Mo				
1	0.08	0.80	0.035	0.025	0.80	12.00-14.00						
2	0.08	1.00	0.035	0.025	1.00	11.50-14.00						Se 0.10-0.30
3	0.09-0.15	1.00	0.035	0.025	1.00	12.00-14.00						
4	0.15-0.25	0.80	0.035	0.025	0.80	12.00-14.00						
5	0.26-0.35	0.80	0.035	0.025	0.80	12.00-14.00						
6	0.36-0.45	0.80	0.035	0.025	0.80	12.00-14.00						
7	0.12	0.80	0.035	0.025	0.80	16.00-18.00						
8	0.10	0.80	0.035	0.025	0.80	16.00-18.00						5 × C ≤ Ti ≤ 0.80
9	0.11-0.17	0.80	0.035	0.025	0.80	16.00-18.00	1.50-2.50					
10	0.17-0.25	0.80	0.035	0.025	0.80	16.00-18.00	1.50-2.50					
11	0.90-1.05	0.80	0.035	0.025	0.80	17.00-19.00						
12	0.15-0.30	8.00-10.00	0.050	0.025	0.80	12.00-14.00	3.70-4.70					
13	0.12	8.00-10.50	0.050	0.025	0.80	16.00-18.00	3.50-4.50					N 0.15-0.25
14	0.12	2.00	0.035	0.025	0.80	17.00-19.00	8.00-10.00					
15	0.08	2.00	0.035	0.025	0.80	17.00-19.00	9.00-11.00					
16	0.03	2.00	0.035	0.025	0.80	17.00-19.00	10.00-12.50					
17	0.12	2.00	0.035	0.025	0.80	17.00-19.00	8.00-10.00					5 × C ≤ Ti ≤ 0.80

18	0.08	2.00	0.035	0.025	0.80	17.00-19.00	9.00-11.00	5 × C ≤ Ti ≤ 0.70
19	0.12	2.00	0.035	0.025	0.80	17.00-19.00	11.00-13.00	5 × C ≤ Ti ≤ 0.80
20	0.08	2.00	0.035	0.025	0.80	17.00-19.00	10.00-13.00	10 × C ≤ Nb ≤ 1.1
21	0.08	2.00	0.035	0.025	0.80	16.00-18.00	11.00-14.00	5 × C ≤ Ti ≤ 0.17
22	0.03	2.00	0.035	0.020	0.80	16.00-18.00	12.00-15.00	2.00-2.50
23	0.08	2.00	0.035	0.025	0.80	16.00-18.00	14.00-16.00	Ti 0.30-0.60
24	0.07	2.00	0.035	0.020	1.00	16.50-18.50	19.00-21.00	Cu 1.80-2.20 7 × C ≤ Ti ≤ 0.70
25	0.06	2.00	0.035	0.020	0.80	22.00-25.00	26.00-29.00	2.50-3.00 Ti 0.50-0.90
26	0.35-0.45	2.00-3.00	0.035	0.025	0.80	8.00-10.00		
27	0.35-0.45	1.90-2.60	0.035	0.025	0.80	9.00-10.50	0.70-0.90	
28	0.12	1.00-1.80	0.035	0.025	0.80	12.00-14.00		Se 0.80-1.80
29	0.15	0.80-1.50	0.035	0.025	0.80	17.00-20.00		Se 0.70-1.20
30	0.15	1.00	0.035	0.025	0.80	24.00-27.00		5 × C ≤ Ti ≤ 0.90
31	0.10-0.20	2.00	0.035	0.025	0.80-2.00	17.00-20.00	8.00-11.00	
32	0.20	1.50	0.035	0.025	2.00-3.00	19.00-22.00	12.00-15.00	
33	0.20	1.50	0.035	0.025	1.00	22.00-25.00	17.00-20.00	
34	0.20	1.50	0.035	0.025	2.00-3.00	24.00-27.00	18.00-21.00	