Designation: B 783 – 04

Standard Specification for Materials for Ferrous Powder Metallurgy (P/M) Structural Parts[1]

This standard is issued under the fixed designation B 783; 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 covers a variety of ferrous P/M structural materials and includes a classification system or material designation code. The classification system used in this specification includes chemical composition, minimum tensile; 0.2 % offset yield strength for as-sintered materials and minimum ultimate tensile strength for heat-treated materials (sinter hardened or quenched and tempered). It also contains minimum density and maximum coercive field strength requirements for iron-phosphorus materials. Material classification is governed by the designation code which is explained in Appendix X1. The data provided display typical mechanical properties achieved under commercial manufacturing procedures. Physical and mechanical property performance characteristics can change as a result of subsequent processing steps beyond those designated in this standard. These changes could improve or degrade the properties.

1.2 Property values stated in inch-pound units are the standard. Conversion factors to SI units may be approximate.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 839 Specification for Iron-Phosphorus Powder Metallurgy (P/M) Parts for Soft Magnetic Applications

B 243 Terminology of Powder Metallurgy

B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings

B 528 Test Method for Transverse Rupture Strength of Metal Powder Specimens

E 8 Test Methods for Tension Testing of Metallic Materials

E 1019 Test Methods for Determination of Carbon, Nitrogen and Oxygen in Iron, Nickel, and Cobalt Alloys

2.2 *Other Standard:*

MPIF Standard 35 Materials Standard for P/M Structural Parts[3]

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B 243. Additional descriptive information is available in the Related Materials section of Vol 02.05 of the *Annual Book of ASTM Standards.*

4. Ordering Information

4.1 Materials for parts conforming to this specification shall be ordered by material designation code.

4.2 Orders for parts under this specification may include the following information:

4.2.1 Certification, if required (see Section 11),

4.2.2 Test methods and mechanical properties other than strength (see 8.2 and 8.3),

4.2.3 Density (see 7.1),

4.2.4 Porosity or oil content (see 7.2), and

4.2.5 Special packaging if required.

5. Materials and Manufacture

5.1 Structural parts shall be made by pressing and sintering metal powders with or without subsequent heat treating. Parts may also be made by repressing or repressing and resintering sintered parts, if necessary, with or without subsequent heat treatment to produce finished parts conforming to the requirements of this specification.

6. Chemical Composition

6.1 The material shall conform to the requirements of Table 1.

6.2 Chemical analysis, if required, shall be made by methods agreed upon by the producer and the user.

6.3 Various analytical test methods are used to determine the chemical composition (see ASTM standards for the appropriate test methods) of P/M materials. Combustion-infra-red

[1] This specification is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.05 on Structural Parts.

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[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.

[3] Available from MPIF, 105 College Road East, Princeton, NJ 08540.

TABLE 1 Chemical Composition Requirements

Material Designation		Chemical Composition, Weight %													
		Iron	Copper	Carbon	Nickel	Molyb-denum	Chro-mium	Man-ganese	Silicon	Sulfur	Phos-phorus	Nitro-gen	Colum-bium	Oxygen	Other
F-0000	Min	Bal.	...	0.0	...	...	...	...	...	...	...	...	...	...	...
F-0000	Max	Bal.	...	0.3	...	...	...	...	...	...	...	...	...	...	2.0
F-0005	Min	Bal.	...	0.3	...	...	...	...	...	...	...	...	...	...	...
F-0005	Max	Bal.	...	0.6	...	...	...	...	...	...	...	...	...	...	2.0
F-0008	Min	Bal.	...	0.6	...	...	...	...	...	...	...	...	...	...	...
F-0008	Max	Bal.	...	0.9	...	...	...	...	...	...	...	...	...	...	2.0
FY-4500	Min	Bal.	...	0.00	...	...	...	...	...	...	0.40	0.00	...	0.00	...
FY-4500	Max	Bal.	...	0.03	...	...	...	...	...	...	0.50	0.01	...	0.10	0.5
FY-8000	Min	Bal.	...	0.00	...	...	...	...	...	...	0.75	0.00	...	0.00	...
FY-8000	Max	Bal.	...	0.03	...	...	...	...	...	...	0.85	0.01	...	0.10	0.5
FX-1000	Min	Bal.	8.0	0.0	...	...	...	...	...	...	...	...	...	...	...
FX-1000	Max	Bal.	14.9	0.3[A]	...	...	...	...	...	...	...	...	...	...	2.0
FX-1005	Min	Bal.	8.0	0.3[A]	...	...	...	...	...	...	...	...	...	...	...
FX-1005	Max	Bal.	14.9	0.6[A]	...	...	...	...	...	...	...	...	...	...	2.0
FX-1008	Min	Bal.	8.0	0.6[A]	...	...	...	...	...	...	...	...	...	...	...
FX-1008	Max	Bal.	14.9	0.9[A]	...	...	...	...	...	...	...	...	...	...	2.0
FX-2000	Min	Bal.	15.0	0.0	...	...	...	...	...	...	...	...	...	...	...
FX-2000	Max	Bal.	25.0	0.3[A]	...	...	...	...	...	...	...	...	...	...	2.0
FX-2005	Min	Bal.	15.0	0.3[A]	...	...	...	...	...	...	...	...	...	...	...
FX-2005	Max	Bal.	25.0	0.6[A]	...	...	...	...	...	...	...	...	...	...	2.0
FX-2008	Min	Bal.	15.0	0.6[A]	...	...	...	...	...	...	...	...	...	...	...
FX-2008	Max	Bal.	25.0	0.9[A]	...	...	...	...	...	...	...	...	...	...	2.0
FC-0200	Min	Bal.	1.5	0.0	...	...	...	...	...	...	...	...	...	...	...
FC-0200	Max	Bal.	3.9	0.3	...	...	...	...	...	...	...	...	...	...	2.0
FC-0205	Min	Bal.	1.5	0.3	...	...	...	...	...	...	...	...	...	...	...
FC-0205	Max	Bal.	3.9	0.6	...	...	...	...	...	...	...	...	...	...	2.0
FC-0208	Min	Bal.	1.5	0.6	...	...	...	...	...	...	...	...	...	...	...
FC-0208	Max	Bal.	3.9	0.9	...	...	...	...	...	...	...	...	...	...	2.0
FC-0505	Min	Bal.	4.0	0.3	...	...	...	...	...	...	...	...	...	...	...
FC-0505	Max	Bal.	6.0	0.6	...	...	...	...	...	...	...	...	...	...	2.0
FC-0508	Min	Bal.	4.0	0.6	...	...	...	...	...	...	...	...	...	...	...
FC-0508	Max	Bal.	6.0	0.9	...	...	...	...	...	...	...	...	...	...	2.0
FC-0808	Min	Bal.	7.0	0.6	...	...	...	...	...	...	...	...	...	...	...
FC-0808	Max	Bal.	9.0	0.9	...	...	...	...	...	...	...	...	...	...	2.0
FC-1000	Min	Bal.	9.0	0.0	...	...	...	...	...	...	...	...	...	...	...
FC-1000	Max	Bal.	11.0	0.3	...	...	...	...	...	...	...	...	...	...	2.0
FN-0200	Min	Bal.	0.0	0.0	1.0	...	...	...	...	...	...	...	...	...	...
FN-0200	Max	Bal.	2.5	0.3	3.0	...	...	...	...	...	...	...	...	...	2.0
FN-0205	Min	Bal.	0.0	0.3	1.0	...	...	...	...	...	...	...	...	...	...
FN-0205	Max	Bal.	2.5	0.6	3.0	...	...	...	...	...	...	...	...	...	2.0
FN-0208	Min	Bal.	0.0	0.6	1.0	...	...	...	...	...	...	...	...	...	...
FN-0208	Max	Bal.	2.5	0.9	3.0	...	...	...	...	...	...	...	...	...	2.0
FN-0405	Min	Bal.	0.0	0.3	3.0	...	...	...	...	...	...	...	...	...	...
FN-0405	Max	Bal.	2.0	0.6	5.5	...	...	...	...	...	...	...	...	...	2.0
FN-0408	Min	Bal.	0.0	0.6	3.0	...	...	...	...	...	...	...	...	...	...
FN-0408	Max	Bal.	2.0	0.9	5.5	...	...	...	...	...	...	...	...	...	2.0
FL-4205	Min	Bal.	...	0.4	0.35	0.50	...	...	...	...	...	...	...	...	...
FL-4205	Max	Bal.	...	0.7	0.55	0.85	...	...	...	...	...	...	...	...	2.0

TABLE 1 *Continued*

Material Designation		Chemical Composition, Weight %													
		Iron	Copper	Carbon	Nickel	Molybdenum	Chromium	Manganese	Silicon	Sulfur	Phosphorus	Nitrogen	Columbium	Oxygen	Other
FL-4605	Min	Bal.	...	0.4	1.70	0.40	...	...	...	...	...	...	...	...	...
FL-4605	Max	Bal.	...	0.7	2.00	1.10	...	...	...	...	...	...	...	...	2.0
FL-4405	Min	Bal.	...	0.4	...	0.75	...	...	...	...	...	...	...	...	...
FL-4405	Max	Bal.	...	0.7	...	0.95	...	...	...	...	...	...	...	...	2.0
FLN-4205	Min	Bal.	...	0.4	1.35[B]	0.49	...	...	...	...	...	...	...	...	...
FLN-4205	Max	Bal.	...	0.7	2.50[B]	0.85	...	...	...	...	...	...	...	...	2.0
FLN2-4405	Min	Bal.	...	0.4	1.00	0.65	...	...	...	...	...	...	...	...	...
FLN2-4405	Max	Bal.	...	0.7	3.00	0.95	...	...	...	...	...	...	...	...	2.0
FLN4-4405	Min	Bal.	...	0.4	3.00	0.65	...	...	...	...	...	...	...	...	...
FLN4-4405	Max	Bal.	...	0.7	5.00	0.95	...	...	...	...	...	...	...	...	2.0
FLN6-4405	Min	Bal.	...	0.4	5.00	0.65	...	...	...	...	...	...	...	...	...
FLN6-4405	Max	Bal.	...	0.7	7.00	0.95	...	...	...	...	...	...	...	...	2.0
FLNC-4405	Min	Bal.	1.0	0.4	1.00	0.65	...	...	...	...	...	...	...	...	...
FLNC-4405	Max	Bal.	3.0	0.7	3.00	0.95	...	...	...	...	...	...	...	...	2.0
FLN2-4408	Min	Bal.	...	0.6	1.0	0.65	...	...	...	...	...	...	...	...	...
FLN2-4408	Max	Bal.	...	0.9	3.0	0.95	...	...	...	...	...	...	...	...	2.0
FLN4-4408	Min	Bal.	...	0.6	3.0	0.65	...	...	...	...	...	...	...	...	...
FLN4-4408	Max	Bal.	...	0.9	5.0	0.95	...	...	...	...	...	...	...	...	2.0
FLN6-4408	Min	Bal.	...	0.6	5.0	0.65	...	...	...	...	...	...	...	...	...
FLN6-4408	Max	Bal.	...	0.9	7.0	0.95	...	...	...	...	...	...	...	...	2.0
FLN-4608	Min	Bal.	...	0.6	3.6[C]	0.39	...	...	...	...	...	...	...		...
FLN-4608	Max	Bal.	...	0.9	5.0[C]	1.10	...	...	...	...	...	...	...		2.0
FLC-4608	Min	Bal.	1.0	0.6	1.6	0.39	...	...	...	...	...	...	...	...	...
FLC-4608	Max	Bal.	3.0	0.9	2.0	1.10	...	...	...	...	...	...	...	...	2.0
FLC-4908	Min	Bal.	1.0	0.6	...	1.30	...	...	...	...	...	...	...	...	...
FLC-4908	Max	Bal.	3.0	0.9	...	1.70	...	...	...	...	...	...	...	...	2.0
FLNC-4408	Min	Bal.	1.0	0.6	1.0	0.65	...	...	...	...	...	...	...	...	...
FLNC-4408	Max	Bal.	3.0	0.9	3.0	0.95	...	...	...	...	...	...	...	...	2.0
FD-0200	Min	Bal.	1.3	0.0	1.55	0.4	...	...	...	...	...	...	...	...	...
FD-0200	Max	Bal.	1.7	0.3	1.95	0.6	...	...	...	...	...	...	...	...	2.0
FD-0205	Min	Bal.	1.3	0.3	1.55	0.4	...	...	...	...	...	...	...	...	...
FD-0205	Max	Bal.	1.7	0.6	1.95	0.6	...	...	...	...	...	...	...	...	2.0
FD-0208	Min	Bal.	1.3	0.6	1.55	0.4	...	...	...	...	...	...	...	...	...
FD-0208	Max	Bal.	1.7	0.9	1.95	0.6	...	...	...	...	...	...	...	...	2.0
FD-0405	Min	Bal.	1.3	0.3	3.60	0.4	...	...	...	...	...	...	...	...	...
FD-0405	Max	Bal.	1.7	0.6	4.40	0.6	...	...	...	...	...	...	...	...	2.0
FD-0408	Min	Bal.	1.3	0.6	3.60	0.4	...	...	...	...	...	...	...	...	...
FD-0408	Max	Bal.	1.7	0.9	4.40	0.6	...	...	...	...	...	...	...	...	2.0
SS-303N1,N2	Min	Bal.	...	0.00	8.0	...	17.0	0.0	0.0	0.15	0.00	0.20	...	...	...
SS-303N1,N2	Max	Bal.	...	0.15	13.0	...	19.0	2.0	1.0	0.30	0.20	0.60	...	...	2.0
SS-303L	Min	Bal.	...	0.00	8.0	...	17.0	0.0	0.0	0.15	0.00	0.00	...	...	...
SS-303L	Max	Bal.	...	0.03	13.0	...	19.0	2.0	1.0	0.30	0.20	0.03	...	...	2.0
SS-304N1,N2	Min	Bal.	...	0.00	8.0	...	18.0	0.0	0.0	0.00	0.00	0.20	...	...	...
SS-304N1,N2	Max	Bal.	...	0.08	12.0	...	20.0	2.0	1.0	0.03	0.04	0.60	...	...	2.0
SS-304H,L	Min	Bal.	...	0.00	8.0	...	18.0	0.0	0.0	0.00	0.00	0.00	...	...	...
SS-304H,L	Max	Bal.	...	0.03	12.0	...	20.0	2.0	1.0	0.03	0.04	0.03	...	...	2.0
SS-316N1,N2	Min	Bal.	...	0.00	10.0	2.0	16.0	0.0	0.0	0.00	0.00	0.20	...	...	...
SS-316N1,N2	Max	Bal.	...	0.08	14.0	3.0	18.0	2.0	1.0	0.03	0.04	0.60	...	...	2.0

TABLE 1 *Continued*

Material Designation		Chemical Composition, Weight %													
		Iron	Copper	Carbon	Nickel	Molybdenum	Chromium	Manganese	Silicon	Sulfur	Phosphorus	Nitrogen	Columbium	Oxygen	Other
SS-316H,L	Min	Bal.	...	0.00	10.0	2.0	16.0	0.0	0.0	0.00	0.00	0.00	...	...	...
SS-316H,L	Max	Bal.	...	0.03	14.0	3.0	18.0	2.0	1.0	0.03	0.04	0.03	...	...	2.0
SS-409L	Min	Bal.	…	0.00	...	...	10.50	0.0	0.0	0.00	0.00	0.00	8 × %C	...	...
SS-409L	Max	Bal.	...	0.03	...	...	11.75	1.0	1.0	0.03	0.04	0.03	0.80	...	2.0
SS-409LE[D]	Min	Bal.	...	0.00	0.0	...	11.50	0.0	0.0	0.00	0.00	0.00	8 × %C	...	...
SS-409LE[D]	Max	Bal.	...	0.03	0.5	...	13.50	1.0	1.0	0.03	0.04	0.03	0.80	...	2.0
SS-410	Min	Bal.	...	0.00	...	...	11.50	0.0	0.0	0.00	0.00	0.20	...	...	...
SS-410	Max	Bal.	...	0.25	...	...	13.50	1.0	1.0	0.03	0.04	0.60	...	...	2.0
SS-410L	Min	Bal.	...	0.00	...	...	11.50	0.0	0.0	0.00	0.00	0.00	...	...	...
SS-410L	Max	Bal.	...	0.03	...	...	13.50	1.0	1.0	0.03	0.04	0.03	...	...	2.0
SS-430N2	Min	Bal.	...	0.00	...	...	16.00	0.0	0.0	0.00	0.00	0.20	...	...	...
SS-430N2	Max	Bal.	...	0.08	...	...	18.00	1.0	1.0	0.03	0.04	0.60	...	...	2.0
SS-430L	Min	Bal.	...	0.00	...	...	16.00	0.0	0.0	0.00	0.00	0.00	...	...	...
SS- 430L	Max	Bal.	...	0.03	...	...	18.00	1.0	1.0	0.03	0.04	0.03	...	...	2.0
SS-434N2	Min	Bal.	...	0.00	...	0.75	16.00	0.0	0.0	0.00	0.00	0.20	...	...	...
SS-434N2	Max	Bal.	...	0.08	...	1.25	18.00	1.0	1.0	0.03	0.04	0.60	...	...	2.0
SS-434L	Min	Bal.	...	0.00	...	0.75	16.00	0.0	0.0	0.00	0.00	0.00	...	...	...
SS-434L	Max	Bal.	...	0.03	...	1.25	18.00	1.0	1.0	0.03	0.04	0.03	...	...	2.0

[A] Carbon, on basis of iron only, may be a metallographic estimate.
[B] At least 1 % of the nickel is admixed as elemental powder.
[C] At least 2 % of the nickel is admixed as elemental powder.
[D] LE = L grade with extended chemical composition.

NOTE—For the Stainless Steels: N1—Nitrogen alloyed. Good strength, low elongation. N2—Nitrogen alloyed. High strength, medium elongation. L—Low carbon. Lower strength, highest elongation. HT—Martensitic grade, heat treated. Highest strength.

absorption and inert gas fusion methods (Test Methods E 1019) are used for the specific elements of carbon, nitrogen, oxygen and sulfur.

6.4 The Chemical Composition Requirements Table (Table 1) designates the limits of metallurgically combined carbon for each alloy. The combined carbon level can be estimated metallographically for sintered P/M steels. When a clear pearlite to ferrite ratio cannot be estimated metallographically, total carbon can be determined using analytical methods (Test Methods E 1019). This would include very low carbon levels (<0.08 %), heat treated steels and materials made from prealloyed base powders or diffusion alloyed powders. When reporting carbon levels, the report should identify whether the carbon is metallurgically combined carbon or total carbon and the test method should be identified. While total carbon will approximate the combined carbon in many materials, free graphite and other carbonaceous material will raise the total carbon level above the level of combined carbon, possibly causing the total carbon content to exceed the combined carbon level specified for the material.

7. Physical Properties

7.1 *Density*:

7.1.1 The user and producer may agree upon a minimum average density for the part or minimum densities for specific regions of the part, or both, except soft magnetic materials, which require a minimum average density as part of the material specification.

7.1.2 Density shall be determined in accordance with Test Method B 328.

7.2 *Porosity*:

7.2.1 The producer and the user may also agree upon a minimum volume oil content for parts that are to be self-lubricating.

7.2.2 Porosity or oil content, or both, shall be determined in accordance with Test Method B 328.

7.2.3 The producer and the user may agree upon a functional test for porosity in parts that are to be self-lubricating, or for permeability where fluid flow must be restricted.

8. Mechanical Properties

8.1 The guaranteed properties shown in Tables 2-11 are included in the suffix of the material designation code. The code is adopted from MPIF Standard 35. All tensile strengths are read as 10^3 psi, and are defined as the 0.2 % offset yield strength for as-sintered materials and the ultimate tensile strength for heat-treated materials (sinter hardened or quenched and tempered). Iron-phosphorus materials (Table 3) contain an alphanumeric suffix and are an exception to this rule. The iron-phosphorus suffix is related to the minimum density and

TABLE 2 Minimum Tensile Strength for Iron and Carbon Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
F-0000-10	10	...
-15	15	...
-20	20	...
F-0005-15	15	...
-20	20	...
-25	25	...
F-0005-50HT	...	50
-60HT	...	60
-70HT	...	70
F-0008-20	20	...
-25	25	...
-30	30	...
-35	35	...
F-0008-55HT	...	55
-65HT	...	65
-75HT	...	75
-85HT	...	85

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

TABLE 3 Minimum Density and Maximum Coercive Field Strength for Iron-Phosphorus

Material Designation Code	Minimum Density	Maximum Coercive Field Strength
	g/cm^3	Oe
FY-4500[A]-20V	6.7	2.0
-20W	6.9	2.0
-17W	6.9	1.7
-20X	7.1	2.0
-17X	7.1	1.7
-20Y	7.3	2.0
-17Y	7.3	1.7
FY-8000-17V	6.7	1.7
-17W	6.9	1.7
-15W	6.9	1.5
-17X	7.1	1.7
-15X	7.1	1.5
-15Y	7.3	1.5

[A] These materials are frequently used in magnetic applications and are specified with minimum density and maximum coercive field strength. One oersted is equal to 79.6 A/m in SI units. Typical magnetic properties can be found in Specification A 839.

maximum coercive field strength and not the tensile yield strength (see X1.3 and X1.4 for details).

8.1.1 Materials that are heat treated (sinter-hardened or quenched and tempered) have the numeric value followed by HT in the suffix.

8.2 The producer and the user should agree upon the method to be used to verify the minimum strength characteristics of the finished parts. Since it is usually impossible to machine tensile test specimens from these parts, alternative strength tests are advisable. An example would be measuring the force needed to break teeth off a gear with the gear properly fixtured.

8.3 If the tensile properties of the materials are required, standard test bars shall be molded from the same mixed powder lot, at the density of a critical region in the part, and processed along with the parts. When a P/M part has a larger ruling section than the test bar being used, the test bar may not be representative of the part. The following procedures are listed with the preferred method first.

TABLE 4 Minimum Tensile Strength for Copper Infiltrated Iron and Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FX-1000-25	25	...
FX-1005-40	40	...
FX-1005-110HT	...	110
FX-1008-50	50	...
FX-1008-110HT	...	110
FX-2000-25	25	...
FX-2005-45	45	...
FX-2005-90HT	...	90
FX-2008-60	60	...
FX-2008-90HT	...	90

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

TABLE 5 Minimum Tensile Strength for Iron-Copper and Copper Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FC-0200-15	15	...
-18	18	...
-21	21	...
-24	24	...
FC-0205-30	30	...
-35	35	...
-40	40	...
-45	45	...
FC-0205-60HT	...	60
-70HT	...	70
-80HT	...	80
-90HT	...	90
FC-0208-30	30	...
-40	40	...
-50	50	...
-60	60	...
FC-0208-50HT	...	50
-65HT	...	65
-80HT	...	80
-95HT	...	95
FC-0505-30	30	...
-40	40	...
-50	50	...
FC-0508-40	40	...
-50	50	...
-60	60	...
FC-0808-45	45	...
FC-1000-20	20	...

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

8.3.1 Transverse rupture strength (see Test Method B 528) can be related to the minimum tensile strength by the ratio of typical transverse rupture strength to typical tensile strength at the same density as the part, as shown in, or interpolated from the tables contained in Appendix X1.

8.3.2 For as-sintered material, flat unmachined tension test specimens (see Test Methods E 8) should be used for determination of 0.2 % offset yield strength.

8.3.3 For determining the tensile strength of heat-treated (sinter-hardened or quenched and tempered) material, round

TABLE 6 Minimum Tensile Strength for Iron-Nickel and Nickel Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FN-0200-15	15	...
-20	20	...
-25	25	...
FN-0205-20	20	...
-25	25	...
-30	30	...
-35	35	...
FN-0205-80HT	...	80
-105HT	...	105
-130HT	...	130
-155HT	...	155
-180HT	...	180
FN-0208-30	30	...
-35	35	...
-40	40	...
-45	45	...
-50	50	...
FN-0208-80HT	...	80
-105HT	...	105
-130HT	...	130
-155HT	...	155
-180HT	...	180
FN-0405-25	25	...
-35	35	...
-45	45	...
FN-0405-80HT	...	80
-105HT	...	105
-130HT	...	130
-155HT	...	155
-180HT	...	180
FN-0408-35	35	...
-45	45	...
-55	55	...

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

test bars should be machined from specially molded, as-sintered bars because heat treated, unmachined specimens yield lower values. The machined tension test specimens (see Test Methods E 8) shall be heat-treated with the production parts.

9. Sampling

9.1 *Lot*—Unless otherwise specified, a lot shall consist of parts of the same form and dimensions made from powders of the same composition, molded, and processed under the same conditions, and submitted for inspection at one time.

9.2 *Chemical Analysis*—When requested on the purchase order, at least one sample for chemical analysis shall be taken from each lot. The analysis shall be performed by a mutually agreed upon method.

9.3 *Mechanical Tests*—The producer and the user shall agree on a representative number of specimens for mechanical tests.

10. Rejection and Rehearing

10.1 Parts that fail to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing.

11. Certification

11.1 When specified in the purchase order or contract, a producer's certification shall be furnished to the user that the parts were manufactured, sampled, tested, and inspected in accordance with this specification and have been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

TABLE 7 Minimum Tensile Strength for Low Alloy Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FL-4205-35	35	...
-40	40	...
-45	45	...
-50	50	...
FL-4205-80HT	...	80
-100HT	...	100
-120HT	...	120
-140HT	...	140
FL-4405-35	35	...
-40	40	...
-45	45	...
-50	50	...
FL-4405-100HT	...	100
-125HT	...	125
-150HT	...	150
-175HT	...	175
FL-4605-35	35	...
-40	40	...
-45	45	...
-50	50	...
FL-4605-80HT	...	80
-100HT	...	100
-120HT	...	120
-140HT	...	140
FLN-4205-40	40	...
-45	45	...
-50	50	...
-55	55	...
FLN-4205-80HT	...	80
-105HT	...	105
-140HT	...	140
-175HT	...	175
FLN2-4405-45	45	...
-50	50	...
-55	55	...
-60	60	...
FLN2-4405-90HT	...	90
-120HT	...	120
-160HT	...	160
-190HT	...	190

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

TABLE 8 Minimum Tensile Strength for Sinter Hardened Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FLC-4608-50HT	...	50
-70HT	...	70
-90HT	...	90
-110HT	...	110
FLNC-4408-60HT	...	60
-85HT	...	85
-105HT	...	105
-130HT	...	130

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

12. Keywords

12.1 ferrous powder metallurgy; ferrous structural parts; powder metallurgy (P/M); structural parts

TABLE 9 Minimum Tensile Strength for Diffusion Alloyed Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
FD-0205-45	45	...
-50	50	...
-55	55	...
-60	60	...
FD-0205-95HT	...	95
-120HT	...	120
-140HT	...	140
-160HT	...	160
FD-0208-50	50	...
-55	55	...
-60	60	...
-65	65	...
FD-0405-55	55	...
-60	60	...
-65	65	...
FD-0405-100HT	...	100
-130HT	...	130
-155HT	...	155
FD-0408-50	50	...
-55	55	...
-60	60	...
-65	65	...

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

TABLE 10 Minimum Tensile Strength for Austenitic Stainless Steel

Material Designation Code	Minimum Strength		Minimum Elongation
	Yield	Ultimate	(in 1 in.)
	10^3 psi[A]		%
SS-303N1-25	25	...	0.0
SS-303N2-35	35	...	3.0
SS-303N2-38	38	...	6.0
SS-303L-12	12	...	12.0
SS-303L-15	15	...	15.0
SS-304N1-30	30	...	0.0
SS-304N2-33	33	...	5.0
SS-304N2-38	38	...	8.0
SS-304L-13	13	...	15.0
SS-304L-18	18	...	18.0
SS-304H-20	20	...	7.0
SS-316N1-25	25	...	0.0
SS-316N2-33	33	...	5.0
SS-316N2-38	38	...	8.0
SS-316L-15	15	...	12.0
SS-316L-22	22	...	15.0
SS-316H-20	20	...	5.0

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

NOTE—For the Stainless Steels: N1—Nitrogen alloyed. Good strength, low elongation. N2—Nitrogen alloyed. High strength, medium elongation. L—Low carbon. Lower strength, highest elongation.

TABLE 11 Minimum Tensile Strength for Ferritic and Martensitic Stainless Steel

Material Designation Code	Minimum Strength		Minimum Elongation
	Yield	Ultimate	(in 1 in.)
	10^3 psi[A]		%
SS-410-90HT	...	90	0.0
SS-410L-20	20	...	10.0
SS-430N2-28	28	...	3.0
SS-430L-24	24	...	14.0
SS-434N2-28	28	...	4.0
SS-434L-24	24	...	10.0

[A] 10^3 psi = 6.895 MPa (6.895 N/mm^2)

NOTE—For the Stainless Steels: N1—Nitrogen alloyed. Good strength, low elongation. N2—Nitrogen alloyed. High strength, medium elongation. L—Low carbon. Lower strength, highest elongation. HT—Martensitic grade, heat treated. Highest strength.

APPENDIX

(Nonmandatory Information)

X1. USE OF THIS SPECIFICATION

X1.1 *PM/Material Code Designation:*

X1.1.1 The P/M material code designation or identifying code for structural P/M parts defines a specific material as to chemical composition and minimum strength expressed in 10^3 psi (6.895 MPa). For example, FC-0208-60 is a P/M copper steel material containing nominally 2 % copper and 0.8 % combined carbon possessing a minimum yield strength of 60×10^3 psi (60 000 psi) in the as-sintered condition.

X1.1.2 The system offers a convenient means for designating both the chemical composition and minimum strength value of any standard P/M material. The density is given for each standard material as one of the typical values and is no

TABLE X1.1 Iron and Carbon Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
F-0000-10	10	...	18	13	1.5	15.0	0.25	3.0	36	16	40 HRF		7	6.1
-15	15	...	25	18	2.5	17.5	0.25	6.0	50	18	60	N/D	10	6.7
-20	20	...	38	25	7.0	23.5	0.28	35.0	95	19	80		14	7.3
F-0005-15	15	...	24	18	<1.0	15.0	0.25	3.0	48	18	25 HRB		9	6.1
-20	20	...	32	23	1.0	16.5	0.25	4.0	64	23	40	N/D	12	6.6
-25	25	...	38	28	1.5	19.5	0.27	5.0	76	28	55		15	6.9
F-0005-50HT	...	50	60	[D]	<0.5	16.5	0.25	3.0	105	43	20 HRC	58 HRC	23	6.6
-60HT	...	60	70		<0.5	18.5	0.27	3.5	120	52	22	58	27	6.8
-70HT	...	70	80		<0.5	20.5	0.27	4.0	140	61	25	58	32	7.0
F-0008-20	20	...	29	25	<0.5	12.5	0.25	2.5	51	28	35 HRB		11	5.8
-25	25	...	35	30	<0.5	16.0	0.25	3.0	61	31	50	N/D	14	6.2
-30	30	...	42	35	<1.0	16.5	0.25	4.0	74	31	60		17	6.6
-35	35	...	57	40	1.0	20.5	0.27	5.0	100	36	70		25	7.0
F-0008-55HT	...	55	65	[D]	<0.5	16.5	0.25	3.0	100	70	22 HRC	60 HRC	26	6.3
-65HT	...	65	75		<0.5	16.5	0.25	4.0	115	80	28	60	30	6.6
-75HT	...	75	85		<0.5	19.5	0.27	4.5	130	90	32	60	34	6.9
-85HT	...	85	95		<0.5	21.5	0.27	5.0	145	100	35	60	38	7.1

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.2 Iron and Carbon Steel (SI)

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
F-0000-10	70	. . .	120	90	1.5	105	0.25	4	250	110	40 HRF		46	6.1
-15	100	. . .	170	120	2.5	120	0.25	8	340	120	60	N/D	65	6.7
-20	140	. . .	260	170	7.0	160	0.28	47	660	130	80		99	7.3
F-0005-15	100	. . .	170	120	<1.0	105	0.25	4	330	125	25 HRB		60	6.1
-20	140	. . .	220	160	1.0	115	0.25	5	440	160	40	N/D	80	6.6
-25	170	. . .	260	190	1.5	135	0.27	7	520	190	55		100	6.9
F-0005-50HT	. . .	340	410	[D]	<0.5	115	0.25	4	720	300	20 HRC	58 HRC	160	6.6
-60HT	. . .	410	480		<0.5	130	0.27	5	830	360	22	58	190	6.8
-70HT	. . .	480	550		<0.5	140	0.27	5	970	420	25	58	220	7.0
F-0008-20	140	. . .	200	170	<0.5	85	0.25	3	350	190	35 HRB		80	5.8
-25	170		240	210	<0.5	110	0.25	4	420	210	50	N/D	100	6.2
-30	210		290	240	<1.0	115	0.25	5	510	210	60		120	6.6
-35	240		390	260	1.0	140	0.27	7	690	250	70		170	7.0
F-0008-55HT	. . .	380	450	[D]	<0.5	115	0.25	4	690	480	22 HRC	60 HRC	180	6.3
-65HT	. . .	450	520		<0.5	115	0.25	5	790	550	28	60	210	6.6
-75HT	. . .	520	590		<0.5	135	0.27	6	900	620	32	60	240	6.9
-85HT	. . .	590	660		<0.5	150	0.27	7	1000	690	35	60	280	7.1

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

longer a requirement of the specification, with the exception of the iron-phosphorus materials as detailed in Tables X1.3 and X1.4.

X1.1.3 Code designations in this specification and revisions thereof apply only to P/M materials for which specifications have been adopted. In order to avoid confusion, the P/M

TABLE X1.3 Iron-Phosphorus

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties												
Mandatory Values[A]				Typical Values[B]								
Material Designation Code[A]		Minimum Density	Maximum Coercive Field	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Hardness	Fatigue Limit 90 % Survival	Density
				Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio		Macro (apparent)		
		g/cm^3	Oe	10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	Rockwell	10^3 psi	g/cm^3
FY-4500	-20V	6.7	2.0	40.0	30.0	5	18.5	0.27	[C]	40 HRB	[C]	6.8
	-20W	6.9	2.0	45.0	32.0	7	20.5	0.27	[C]	45 HRB	[C]	7.0
	-17W	6.9	1.7	45.0	32.0	10	20.5	0.27	[C]	45 HRB	[C]	7.0
	-20X	7.1	2.0	50.0	35.0	7	22.5	0.28	[C]	55 HRB	[C]	7.2
	-17X	7.1	1.7	55.0	39.0	12	22.5	0.28	[C]	55 HRB	[C]	7.2
	-20Y	7.3	2.0	55.0	38.0	9	24.5	0.28	[C]	65 HRB	[C]	7.4
	-17Y	7.3	1.7	60.0	41.0	15	24.5	0.28	[C]	65 HRB	[C]	7.4
FY-8000	-17V	6.7	1.7	48.0	40.0	2	18.5	0.27	[C]	55 HRB	[C]	6.8
	-17W	6.9	1.7	50.0	45.0	3	20.5	0.27	[C]	65 HRB	[C]	7.0
	-15W	6.9	1.5	53.0	45.0	4	20.5	0.27	[C]	65 HRB	[C]	7.0
	-17X	7.1	1.7	55.0	50.0	3	22.5	0.28	[C]	70 HRB	[C]	7.2
	-15X	7.1	1.5	57.0	48.0	4	22.5	0.28	[C]	70 HRB	[C]	7.2
	-15Y	7.3	1.5	62.0	53.0	4	24.5	0.28	[C]	75 HRB	[C]	7.4

[A] Suffix numbers represent maximum coercive field strength values (oersteds × 10); the letter suffix indicates the minimum density in g/cm^3.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Additional data in preparation will appear in subsequent editions of this standard.

N/D—Not Determined for the purposes of this standard.

TABLE X1.4 Iron-Phosphorus (SI)

P/M Material Properties													
Mandatory Values[A]				TypicalValues[B]									
Material Designation Code[A]		Minimum Density	Maximum Coercive Field	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Hardness	Fatigue Limit 90 % Survival	Density	
				Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio		Macro (apparent)			
		g/cm^3	A/m	MPa	MPa	%	GPa		J	Rockwell	MPa	g/cm^3	
FY-4500	-20V	6.7	160	275	205	5	130	0.27	[C]	40 HRB	[C]	6.8	
	-20W	6.9	160	310	220	7	140	0.27	[C]	45 HRB	[C]	7.0	
	-17W	6.9	135	310	220	10	140	0.27	[C]	45 HRB	[C]	7.0	
	-20X	7.1	160	345	240	7	155	0.28	[C]	55 HRB	[C]	7.2	
	-17X	7.1	135	380	270	12	155	0.28	[C]	55 HRB	[C]	7.2	
	-20Y	7.3	160	380	260	9	170	0.28	[C]	65 HRB	[C]	7.4	
	-17Y	7.3	135	415	280	15	170	0.28	[C]	65 HRB	[C]	7.4	
FY-8000	-17V	6.7	135	330	275	2	130	0.27	[C]	55 HRB	[C]	6.8	
	-17W	6.9	135	345	310	3	140	0.27	[C]	65 HRB	[C]	7.0	
	-15W	6.9	120	365	310	4	140	0.27	[C]	65 HRB	[C]	7.0	
	-17X	7.1	135	380	345	3	155	0.28	[C]	70 HRB	[C]	7.2	
	-15X	7.1	120	390	330	4	155	0.28	[C]	70 HRB	[C]	7.2	
	-15Y	7.3	120	430	365	4	170	0.28	[C]	75 HRB	[C]	7.4	

[A] Suffix numbers represent maximum coercive field strength values (oersteds × 10); the letter suffix indicates the minimum density in g/cm^3.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Additional data in preparation will appear in subsequent editions of this standard.
N/D—Not Determined for the purposes of this standard.

material designation coding system is intended for use only with such materials and should not be used to create non-standard materials. However, the use of designations such as FC-0208 or FN-0205 to denote materials of a specified composition is permitted. The explanatory notes, property values, and other contents of this standard have no application to any other materials.

X1.1.4 In the coding system, the prefix letters denote the general type of material. For example, the prefix FC represents iron (F) and copper (C), which is known as iron-copper and copper steel. The prefix letter codes are as follows:

X1.1.4.1 C—Copper.

X1.1.4.2 F—Iron.

X1.1.4.3 FY—Iron-phosphorus.

X1.1.4.4 FC—Iron-copper and Copper Steel.

X1.1.4.5 FN—Iron-nickel and Nickel Steel.

X1.1.4.6 FX—Infiltrated Iron or Steel.

X1.1.4.7 FL—Prealloyed Ferrous material except Stainless Steel.

X1.1.4.8 FLN, FLNC, or FLC Prealloyed Low Alloy Steel Powder, with Elemental Additions.

X1.1.4.9 FD—Diffusion Alloyed Steel.

X1.1.4.10 N—Nickel.

X1.1.4.11 SS—Stainless Steel.

X1.1.5 For an illustration of P/M ferrous material designation coding, see Fig. X1.1.

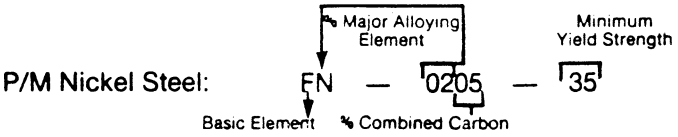

FIG. X1.1 Illustration of P/M Ferrous Material Designation Coding

X1.2 *Prefix and Four-Digit Code:*

X1.2.1 In ferrous materials, the major alloying elements (except combined carbon) are included in the prefix letter code. Other elements are excluded from the code but are represented in the chemical composition that appears with each standard material. The first two digits of the four-digit code indicate the percentage of the major alloying constituent present. In the iron-phosphorus material, the first two digits represent the percentage of phosphorus multiplied by 100 to more accurately indicate the nominal amount of phosphorus.

X1.2.2 Combined carbon content in ferrous materials is designated by the last two numbers in the four-digit series. There are three carbon ranges designated as follows:

Carbon Ranges	Code Designation
from 0.0 % to 0.3 %[A]	00
from 0.3 % to 0.6 %[B]	05
from 0.6 % to 0.9 %	08

[A] Iron-phosphorus material carbon range is 0.00 % to 0.03 % when designated as "00."

[B] Carbon range for the low alloy series is 0.4 % to 0.7 % when designated as "05."

X1.3 *Suffix Digit Code*—The two- or three-digit suffix represents the minimum strength value, expressed in 10^3 psi (6.895 MPa (6.895 N/mm^2)) that the user can expect from the P/M material possessing that chemical composition. In the as-sintered condition the strength is tensile yield; in the heat-treated condition, it is ultimate tensile (see Minimum Value, Tables X1.1-X1.20). An exception to this is found in the soft magnetic "FY" material in which the suffix represents the minimum density and maximum coercive field strength. The suffix number represents the maximum coercive field strength (ten times the value in oersteds) instead of the yield or tensile strength. For example FY-4500-20W would represent an iron-0.45 % phosphorus alloy.

TABLE X1.5 Copper Infiltrated Iron and Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.
NOTE 4—All data based on single-pass infiltration.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FX-1000-25	25	...	51	32	7.0	23.5	0.28	25.0	132	33	65 HRB	N/D	19	7.3
FX-1005-40	40	...	77	50	4.0	23.5	0.28	13.0	158	53	82 HRB	N/D	29	7.3
FX-1005-110HT	...	110	120	[D]	<0.5	23.5	0.28	7.0	210	110	38 HRC	55 HRC	33	7.3
FX-1008-50	50	...	87	60	3.0	23.5	0.28	10.0	166	71	89 HRB	N/D	33	7.3
FX-1008-110HT	...	110	120	[D]	<0.5	23.5	0.28	6.5	189	115	43 HRC	58 HRC	41	7.3
FX-2000-25	25	...	46	37	3.0	21.0	0.24	15.0	144	41	66 HRB	N/D	17	7.3
FX-2005-45	45	...	75	60	1.5	21.0	0.24	8.0	148	60	85 HRB	N/D	20	7.3
FX-2005-90HT	...	90	100	[D]	<0.5	21.0	0.24	7.0	171	71	36 HRC	55 HRC	23	7.3
FX-2008-60	60	...	80	70	1.0	21.0	0.24	7.0	156	70	90 HRB	N/D	23	7.3
FX-2008-90HT	...	90	100	[D]	<0.5	21.0	0.24	5.0	159	74	36 HRC	58 HRC	27	7.3

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.6 Copper Infiltrated Iron and Steel (SI)

NOTE—All data based on single-pass infiltration.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Marco (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FX-1000-25	170	…	350	220	7.0	160	0.28	34	910	230	65 HRB	N/D	133	7.3
FX-1005-40	280	…	530	340	4.0	160	0.28	18	1090	370	82 HRB	N/D	200	7.3
FX-1005-110HT	…	760	830	[D]	<0.5	160	0.28	9	1450	760	38 HRC	55 HRC	230	7.3
FX-1008-50	340	…	600	410	3.0	160	0.28	14	1140	490	89 HRB	N/D	230	7.3
FX-1008-110HT	…	760	830	[D]	<0.5	160	0.28	9	1300	790	43 HRC	58 HRC	280	7.3
FX-2000-25	170	…	320	260	3.0	145	0.24	20	990	280	66 HRB	N/D	122	7.3
FX-2005-45	310	…	520	410	1.5	145	0.24	11	1020	410	85 HRB	N/D	140	7.3
FX-2005-90HT	…	620	690	[D]	<0.5	145	0.24	9	1180	490	36 HRC	55 HRC	160	7.3
FX-2008-60	410	…	550	480	1.0	145	0.24	9	1080	480	90 HRB	N/D	160	7.3
FX-2008-90HT	…	620	690	[D]	<0.5	145	0.24	7	1100	510	36 HRC	58 HRC	190	7.3

[A] Suffix numbers represent minimum strength values in 10^3 psi (see page 2); yield in the as-sintered condition and ultimate in the heat treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat treated (HT) materials: 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials (see page 3).

N/D—Not Determined for the purposes of this standard.

X1.4 *Suffix Letter Code*—When the code designation HT appears after the suffix digits it is understood that the P/M material specified has been heat-treated (sinter hardened or quenched and tempered) and that the strength represented is ultimate tensile in 10^3 psi (6.895 MPa (6.895 N/mm^2)). The letter suffix in the iron-phosphorus materials represents the density. The density is represented alphabetically by the following letters:

Suffix Letter	Minimum Density (g/cm^3)
U	6.5
V	6.7
W	6.9
X	7.1
Y	7.3
Z	7.4

NOTE X1.1—The example used in X1.3 (FY-4500-20W) now becomes an iron-0.45 % phosphorus alloy with a minimum density of 6.9 g/cm^3.

TABLE X1.7 Iron-Copper and Copper Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FC-0200-15	15	...	25	20	1.0	14.0	0.25	4.5	45	18	11 HRB		10	6.0
-18	18	...	28	23	1.5	16.5	0.25	5.0	51	21	18	N/D	11	6.3
-21	21	...	31	26	1.5	16.5	0.25	5.5	56	23	26		12	6.6
-24	24	...	34	29	2.0	19.5	0.27	6.0	63	26	36		13	6.9
FC-0205-30	30	...	35	35	<1.0	14.0	0.25	<2.0	60	35	37 HRB		13	6.0
-35	35	...	40	40	<1.0	16.5	0.25	3.0	75	40	48	N/D	15	6.3
-40	40	...	50	45	<1.0	17.5	0.25	5.0	95	45	60		21	6.7
-45	45	...	60	50	<1.0	21.5	0.27	8.0	115	50	72		31	7.1
FC-0205-60HT	...	60	70	[D]	<0.5	16.0	0.25	2.5	95	57	19 HRC	58 HRC	27	6.2
-70HT	...	70	80		<0.5	15.5	0.25	3.5	110	71	25	58	30	6.5
-80HT	...	80	90		<0.5	18.5	0.27	4.5	120	86	31	58	34	6.8
-90HT	...	90	100		<0.5	20.5	0.27	5.5	135	95	36	58	38	7.0
FC-0208-30	30	...	35	35	<1.0	12.5	0.25	<2.0	60	40	50 HRB		13	5.8
-40	40	...	50	45	<1.0	16.5	0.25	2.0	90	45	61	N/D	17	6.3
-50	50	...	60	55	<1.0	17.5	0.25	5.0	125	50	73		23	6.7
-60	60	...	75	65	<1.0	22.5	0.28	7.0	155	55	84		33	7.2
FC-0208-50HT	...	50	65	[D]	<0.5	15.0	0.25	2.5	95	58	20 HRC	60 HRC	25	6.1
-65HT	...	65	75		<0.5	17.5	0.27	3.5	110	72	27	60	30	6.4
-80HT	...	80	90		<0.5	18.5	0.27	4.5	130	91	35	60	35	6.8
-95HT	...	95	105		<0.5	21.5	0.27	5.5	150	105	43	60	40	7.1
FC-0505-30	30	...	44	36	<0.5	12.5	0.25	3.0	77	50	51 HRB		17	5.8
-40	40	...	58	47	<0.5	16.5	0.25	4.5	102	54	62	N/D	22	6.3
-50	50	...	71	56	<1.0	17.5	0.25	5.0	124	58	72		27	6.7
FC-0508-40	40	...	58	50	<0.5	13.0	0.25	3.0	100	58	60 HRB		22	5.9
-50	50	...	68	60	<0.5	16.5	0.25	3.5	120	63	68	N/D	26	6.3
-60	60	...	82	70	<1.0	18.5	0.27	4.5	145	68	80		31	6.8
FC-0808-45	45	...	55	50	<0.5	14.0	0.27	3.0	85	62	65 HRB	N/D	21	6.0
FC-1000-20	20	...	30	26	<1.0	14.0	0.27	3.5	53	33	15 HRB	N/D	11	6.0

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

X1.5 *Data Source*—Information used in compiling this specification was contributed by the membership of ASTM Committee B09 on Metal Powders and Metal Powder Products and the MPIF Standards Committee. These technical data are on file at MPIF Headquarters, Princeton, NJ, and are reproduced in this specification with the permission of the Metal Powder Industries Federation.

TABLE X1.8 Iron-Copper and Copper Steel (SI)

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FC-0200-15	100	…	170	140	1.0	95	0.25	6	310	120	11 HRB		70	6.0
-18	120	…	190	160	1.5	115	0.25	7	350	140	18	N/D	72	6.3
-21	140	…	210	180	1.5	115	0.25	7	390	160	26		80	6.6
-24	170		230	200	2.0	135	0.27	8	430	180	36		87	6.9
FC-0205-30	210	…	240	240	<1.0	95	0.25	<3	410	240	37 HRB		90	6.0
-35	240	…	280	280	<1.0	115	0.25	4	520	280	48	N/D	100	6.3
-40	280	…	340	310	<1.0	120	0.25	7	660	310	60		140	6.7
-45	310	…	410	340	<1.0	150	0.27	10	790	340	72		210	7.1
FC-0205-60HT	…	410	480	[D]	<0.5	110	0.25	3	660	390	19 HRC	58 HRC	190	6.2
-70HT	…	480	550		<0.5	105	0.25	5	760	490	25	58	210	6.5
-80HT	…	550	620		<0.5	130	0.27	6	830	590	31	58	230	6.8
-90HT	…	620	690		<0.5	140	0.27	7	930	660	36	58	260	7.0
FC-0208-30	210	…	240	240	<1.0	85	0.25	<3	410	280	50 HRB		90	5.8
-40	280	…	340	310	<1.0	115	0.25	3	620	310	61	N/D	120	6.3
-50	340	…	410	380	<1.0	120	0.25	7	860	340	73		160	6.7
-60	410	…	520	450	<1.0	155	0.28	9	1070	380	84		230	7.2
FC-0208-50HT	…	340	450	[D]	<0.5	105	0.25	3	660	400	20 HRC	60 HRC	170	6.1
-65HT	…	450	520		<0.5	120	0.27	5	760	500	27	60	210	6.4
-80HT	…	550	620		<0.5	130	0.27	6	900	630	35	60	240	6.8
-95HT	…	660	720		<0.5	150	0.27	7	1030	720	43	60	280	7.1
FC-0505-30	210	…	300	250	<0.5	85	0.25	4	530	340	51 HRB		114	5.8
-40	280	…	400	320	<0.5	115	0.25	6	700	370	62	N/D	152	6.3
-50	340	…	490	390	<1.0	120	0.25	7	850	400	72		186	6.7
FC-0508-40	280	…	400	340	<0.5	90	0.25	4	690	400	60 HRB		152	5.9
-50	340	…	470	410	<0.5	115	0.25	5	830	430	68	N/D	179	6.3
-60	410	…	570	480	<1.0	130	0.27	6	1000	470	80		217	6.8
FC-0808-45	310	…	380	340	<0.5	95	0.27	4	590	430	65 HRB	N/D	144	6.0
FC-1000-20	140	…	210	180	<1.0	95	0.27	5	370	230	15 HRB	N/D	80	6.0

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.9 Iron-Nickel and Nickel Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FN-0200-15	15	...	25	17	3.0	16.5	0.25	10.0	50	16	55 HRF		10	6.6
-20	20	...	35	25	5.0	20.5	0.27	20.0	80	18	75	N/D	13	7.0
-25	25	...	40	30	10.0	23.5	0.28	50.0	105	20	80		15	7.3
FN-0205-20	20	...	40	25	1.5	16.5	0.25	6.0	65	25	44 HRB		14	6.6
-25	25	...	50	30	2.5	19.5	0.27	12.0	100	30	59		18	6.9
-30	30	...	60	35	4.0	22.5	0.28	21.0	125	35	69	N/D	22	7.2
-35	35	...	70	40	5.5	24.5	0.28	34.0	150	40	78		26	7.4
FN-0205-80HT	...	80	90	[D]	<0.5	16.5	0.25	3.5	120	60	23 HRC	55 HRC	26	6.6
-105HT	...	105	120		<0.5	19.5	0.27	4.5	160	80	29	55	35	6.9
-130HT	...	130	145		<0.5	21.5	0.27	6.0	190	100	33	55	42	7.1
-155HT	...	155	160		<0.5	22.5	0.28	7.0	215	120	36	55	47	7.2
-180HT	...	180	185		<0.5	24.5	0.28	9.5	250	140	40	55	54	7.4
FN-0208-30	30	...	45	35	1.5	17.5	0.25	5.5	85	35	63 HRB		16	6.7
-35	35	...	55	40	1.5	19.5	0.27	8.0	105	40	71		20	6.9
-40	40	...	70	45	2.0	21.5	0.27	11.0	130	45	77	N/D	25	7.1
-45	45	...	80	50	2.5	23.5	0.28	16.0	155	50	83		28	7.3
-50	50	...	90	55	3.0	24.5	0.28	21.0	170	55	88		32	7.4
FN-0208-80HT	...	80	90	[D]	<0.5	17.5	0.25	4.0	120	99	26 HRC	57 HRC	29	6.7
-105HT	...	105	120		<0.5	19.5	0.27	4.5	150	124	31	57	38	6.9
-130HT	...	130	145		<0.5	20.5	0.27	5.5	185	136	35	57	46	7.0
-155HT	...	155	170		<0.5	22.5	0.28	7.0	220	162	39	57	54	7.2
-180HT	...	180	195		<0.5	24.5	0.28	8.0	250	188	42	57	62	7.4
FN-0405-25	25	...	40	30	<1.0	15.5	0.25	4.5	65	33	49 HRB		14	6.5
-35	35	...	60	40	3.0	20.5	0.27	14.5	120	40	71	N/D	22	7.0
-45	45	...	90	50	4.5	24.5	0.28	33.5	175	45	84		32	7.4
FN-0405-80HT	...	80	85	[D]	<0.5	15.5	0.25	4.0	115	67	19 HRC	55 HRC	26	6.5
-105HT	...	105	110		<0.5	18.5	0.27	5.0	145	89	25	55	34	6.8
-130HT	...	130	135		<0.5	20.5	0.27	6.5	200	103	31	55	42	7.0
-155HT	...	155	160		<0.5	23.5	0.28	9.5	245	124	37	55	49	7.3
-180HT	...	180	185		<0.5	24.5	0.28	13.0	280	132	40	55	57	7.4
FN-0408-35	35	...	45	40	1.0	15.5	0.25	4.0	75	37	67 HRB		16	6.5
-45	45	...	65	50	1.0	19.5	0.27	7.5	115	50	78	N/D	23	6.9
-55	55	...	80	60	1.0	22.5	0.28	11.0	150	59	87		28	7.2

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 500°F (260°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.10 Iron-Nickel and Nickel Steel (SI)

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FN-0200-15	100	…	170	120	3.0	115	0.25	14	340	110	55 HRF		70	6.6
-20	140	…	240	170	5.0	140	0.27	27	550	120	75	N/D	91	7.0
-25	170	…	280	210	10.0	160	0.28	68	720	140	80		103	7.3
FN-0205-20	140	…	280	170	1.5	115	0.25	8	450	170	44 HRB		100	6.6
-25	170	…	340	210	2.5	135	0.27	16	690	210	59		120	6.9
-30	210	…	410	240	4.0	155	0.28	28	860	240	69	N/D	150	7.2
-35	240	…	480	280	5.5	170	0.28	46	1030	280	78		180	7.4
FN-0205-80HT	…	550	620	[D]	<0.5	115	0.25	5	830	410	23 HRC	55 HRC	180	6.6
-105HT	…	720	830		<0.5	135	0.27	6	1110	550	29	55	240	6.9
-130HT	…	900	1000		<0.5	150	0.27	8	1310	690	33	55	290	7.1
-155HT	…	1070	1100		<0.5	155	0.28	9	1480	830	36	55	320	7.2
-180HT	…	1240	1280		<0.5	170	0.28	13	1720	970	40	55	370	7.4
FN-0208-30	210	…	310	240	1.5	120	0.25	7	590	240	63 HRB		110	6.7
-35	240	…	380	280	1.5	135	0.27	11	720	280	71		140	6.9
-40	280	…	480	310	2.0	150	0.27	15	900	310	77	N/D	170	7.1
-45	310	…	550	340	2.5	160	0.28	22	1070	340	83		190	7.3
-50	340	…	620	380	3.0	170	0.28	28	1170	380	88		220	7.4
FN-0208-80HT	…	550	620	[D]	<0.5	120	0.25	5	830	680	26 HRC	57 HRC	200	6.7
-105HT	…	720	830		<0.5	135	0.27	6	1030	850	31	57	260	6.9
-130HT	…	900	1000		<0.5	140	0.27	7	1280	940	35	57	320	7.0
-155HT	…	1070	1170		<0.5	155	0.28	9	1520	1120	39	57	370	7.2
-180HT	…	1240	1340		<0.5	170	0.28	11	1720	1300	42	57	430	7.4
FN-0405-25	170	…	280	210	<1.0	105	0.25	6	450	230	49 HRB		100	6.5
-35	240	…	410	280	3.0	140	0.27	20	830	280	71	N/D	150	7.0
-45	310	…	620	340	4.5	170	0.28	45	1210	310	84		220	7.4
FN-0405-80HT	…	550	590	[D]	<0.5	105	0.25	5	790	460	19 HRC	55 HRC	180	6.5
-105HT	…	720	760		<0.5	130	0.27	7	1000	610	25	55	230	6.8
-130HT	…	900	930		<0.5	140	0.27	9	1380	710	31	55	290	7.0
-155HT	…	1070	1100		<0.5	160	0.28	13	1690	850	37	55	340	7.3
-180HT	…	1240	1280		<0.5	170	0.28	18	1930	910	40	55	390	7.4
FN-0408-35	240	…	310	280	1.0	105	0.25	5	520	260	67 HRB		110	6.5
-45	310	…	450	340	1.0	135	0.27	10	790	340	78	N/D	160	6.9
-55	380	…	550	410	1.0	155	0.28	15	1030	410	87		190	7.2

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 500°F (260°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.11 Low Alloy Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FL-4205-35	35	…	52	42	1.0	18.5	0.27	6.0	100	42	60 HRB	N/D	20	6.8
-40	40	…	58	47	1.0	20.0	0.27	9.0	115	47	66		27	6.95
-45	45	…	66	52	1.5	21.5	0.27	12.0	125	52	70		32	7.10
-50	50	…	73	58	2.0	23.5	0.28	17.0	150	56	75		40	7.30
FL-4205-80HT	…	80	90	[D]	<0.5	16.5	0.25	5.0	135	80	28 HRC	60 HRC	30	6.60
-100HT	…	100	110		<0.5	18.5	0.27	7.0	160	110	32	60	37	6.80
-120HT	…	120	130		<0.5	20.5	0.27	8.0	185	140	36	60	44	7.00
-140HT	…	140	150		<0.5	22.5	0.28	12.0	215	170	39	60	50	7.20
FL 4405-35	35	…	52	42	1.0	17.5	0.25	6.0	100	39	60 HRB	N/D	20	6.70
-40	40	…	58	47	1.0	19.5	0.27	11.0	125	45	67		27	6.90
-45	45	…	66	52	1.5	21.5	0.27	16.0	140	52	73		32	7.10
-50	50	…	73	58	2.0	23.5	0.28	22.0	165	56	80		40	7.30
FL-4405-100HT	…	100	110	[D]	<1.0	17.5	0.25	5.5	160	135	24 HRC	60 HRC	34	6.70
-125HT	…	125	135		<1.0	19.5	0.27	7.0	200	155	29	60	42	6.90
-150HT	…	150	160		<1.0	21.5	0.27	9.0	230	175	34	60	48	7.10
-175HT	…	175	185		<1.0	23.5	0.28	14.0	280	195	38	60	58	7.30
FL-4605-35	35	…	52	42	1.0	18.0	0.27	6.0	100	42	60 HRB	N/D	20	6.75
-40	40	…	58	47	1.0	20.0	0.27	11.0	120	45	65		27	6.95
-45	45	…	66	52	1.5	22.0	0.28	16.0	140	52	71		32	7.15
-50	50	…	73	58	2.0	24.0	0.28	22.0	165	57	77		40	7.35
FL-4605-80HT	…	80	85	[D]	<0.5	16.0	0.25	4.5	130	91	24 HRC	60 HRC	29	6.55
-100HT	…	100	110		<0.5	18.0	0.27	6.0	165	114	29	60	37	6.75
-120HT	…	120	130		<0.5	20.0	0.27	8.0	195	139	34	60	46	6.95
-140HT	…	140	155		<0.5	22.5	0.28	12.0	230	170	39	60	53	7.20
FLN-4205-40	40	…	58	47	1.0	16.5	0.25	6.0	105	45	64 HRB	N/D	20	6.60
-45	45	…	66	52	1.0	18.5	0.27	8.0	125	50	70		27	6.80
-50	50	…	73	58	1.5	21.0	0.27	13.0	150	56	77		32	7.05
-55	55	…	87	63	2.0	23.5	0.28	22.0	175	60	83		40	7.30
FLN-4205-80HT	…	80	90	[D]	<1.0	16.5	0.25	5.0	130	125	24 HRC	60 HRC	28	6.60
-105HT	…	105	115		<1.0	18.5	0.27	7.0	170	145	30	60	36	6.80
-140HT	…	140	150		<1.0	21.0	0.27	9.0	230	170	36	60	47	7.05
-175HT	…	175	185		1.0	23.5	0.28	14.0	290	200	42	60	58	7.30
FLN2-4405-45	45	…	59	53	0.5	16.5	0.25	5.0	125	50	75 HRB	N/D	19	6.60
-50	50	…	66	58	1.0	18.5	0.27	7.0	155	55	80	N/D	25	6.80
-55	55	…	80	64	1.5	21.0	0.27	12.0	190	62	85	N/D	32	7.05
-60	60	…	100	70	2.0	23.5	0.28	22.0	220	70	90	N/D	41	7.30
FLN2-4405-90HT	…	90	100	…	<0.5	16.5	0.25	4.0	155	100	28 HRC	60 HRC	32	6.60
-120HT	…	120	130	…	<0.5	18.5	0.27	6.0	210	125	32	60 HRC	41	6.80
-160HT	…	160	170	…	<0.5	21.0	0.27	10.0	260	160	38	60 HRC	50	7.05
-190HT	…	190	210	180	0.5	23.5	0.28	13.0	320	190	44	60 HRC	59	7.30

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.12 Low Alloy Steel (SI)

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FL-4205-35	240	…	360	290	1.0	130	0.27	8	690	290	60 HRB		140	6.80
-40	280	…	400	320	1.0	140	0.27	12	790	320	66	N/D	190	6.95
-45	310	…	460	360	1.5	150	0.27	16	860	360	70		220	7.10
-50	340	…	500	400	2.0	160	0.28	23	1030	390	75		280	7.30
FL-4205-80HT	…	550	620	[D]	<0.5	115	0.25	7	930	550	28 HRC	60 HRC	210	6.60
-100HT	…	690	760		<0.5	130	0.27	9	1100	760	32	60	260	6.80
-120HT	…	830	900		<0.5	140	0.27	11	1280	970	36	60	300	7.00
-140HT	…	970	1030		<0.5	155	0.28	16	1480	1170	39	60	340	7.20
FL-4405-35	240	…	360	290	1.0	120	0.25	8	690	270	60 HRB		140	6.70
-40	280	…	400	320	1.0	135	0.27	15	860	310	67	N/D	190	6.90
-45	310	…	460	360	1.5	150	0.27	22	970	360	73		220	7.10
-50	340	…	500	400	2.0	160	0.28	30	1140	390	80		280	7.30
FL-4405-100HT	…	690	760	[D]	<1.0	120	0.25	7	1100	930	24 HRC	60 HRC	230	6.70
-125HT	…	860	930		<1.0	135	0.27	9	1380	1070	29	60	290	6.90
-150HT	…	1030	1100		<1.0	150	0.27	12	1590	1210	34	60	330	7.10
-175HT	…	1210	1280		<1.0	160	0.28	19	1930	1340	38	60	400	7.30
FL-4605-35	240	…	360	290	1.0	125	0.27	8	690	290	60 HRB		140	6.75
-40	280	…	400	320	1.0	140	0.27	15	830	310	65	N/D	190	6.95
-45	310	…	460	360	1.5	150	0.28	22	970	360	71		220	7.15
-50	340	…	500	400	2.0	165	0.28	30	1140	390	77		280	7.35
FL-4605-80HT	…	550	590	[D]	<0.5	110	0.25	6	900	630	24 HRC	60 HRC	200	6.55
-100HT	…	690	760		<0.5	125	0.27	8	1140	790	29	60	260	6.75
-120HT	…	830	900		<0.5	140	0.27	11	1340	960	34	60	320	6.95
-140HT	…	970	1070		<0.5	155	0.28	16	1590	1170	39	60	370	7.20
FLN-4205-40	280	…	400	320	1.0	115	0.25	8	720	310	64 HRB		140	6.60
-45	310	…	460	360	1.0	130	0.27	11	860	340	70	N/D	190	6.80
-50	340	…	500	400	1.5	145	0.27	18	1030	390	77		220	7.05
-55	380	…	600	430	2.0	160	0.28	30	1210	410	83		280	7.30
FLN-4205-80HT	…	550	620	[D]	<1.0	115	0.25	7	900	860	24 HRC	60 HRC	190	6.60
-105HT	…	720	790		<1.0	130	0.27	9	1170	1000	30	60	250	6.80
-140HT	…	970	1030		<1.0	145	0.27	12	1590	1170	36	60	320	7.05
-175HT	…	1210	1280		1.0	160	0.28	19	2000	1380	42	60	400	7.30
FLN2-4405-45	310	…	410	360	0.5	115	0.25	7	860	340	75 HRB		130	6.60
-50	340	…	450	400	1.0	130	0.27	9	1070	380	80	N/D	170	6.80
-55	380	…	550	440	1.5	145	0.27	16	1310	430	85		220	7.05
-60	410	…	690	480	2.0	160	0.28	30	1520	480	90		280	7.30
FLN2-4405-90HT	…	620	690	…	<0.5	115	0.25	5	1070	690	28 HRC	60 HRC	220	6.60
-120HT	…	830	900	…	<0.5	130	0.27	8	1450	860	32	60 HRC	280	6.80
-160HT	…	1100	1170	…	<0.5	145	0.27	14	1800	1100	38	60 HRC	340	7.05
-190HT	…	1310	1450	1240	0.5	160	0.28	18	2210	1310	44	60 HRC	410	7.30

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.13 Sinter Hardened Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties

Material Designation Code	Minimum Values[A]		Typical Values[B]											
	Minimum Strength		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate[C]	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FLC-4608-50HT	...	50	60	[D]	<1.0	16.5	0.25	5.0	120	[E]	20 HRC	55 HRC	16	6.60
-70HT	...	70	80		<1.0	18.5	0.27	7.0	150		26	55	24	6.80
-90HT	...	90	100		<1.0	20.5	0.27	9.0	190		31	55	33	7.00
-110HT	...	110	120		<1.0	22.5	0.28	14.0	230		37	55	42	7.20
FLNC-4408-60HT	...	60	70	[D]	<1.0	16.5	0.25	4.0	160	75	18 HRC	55 HRC	18	6.60
-85HT	...	85	95		<1.0	18.5	0.27	7.0	190	85	21	55	26	6.80
-105HT	...	105	115		<1.0	20.5	0.27	12.0	220	95	25	55	34	7.00
-130HT	...	130	140		1.0	22.5	0.28	16.0	250	105	30	55	42	7.20

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.
[E] Additional data in preparation will appear in subsequent editions of this standard.

TABLE X1.14 Sinter Hardened Steel (SI)

P/M Material Properties

Material Designation Code	Minimum Values[A]		Typical Values[B]											
	Minimum Strength		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival	Density
	Yield	Ultimate[C]	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FLC-4608-50HT	...	340	410	[D]	<1.0	115	0.25	7	830	[E]	20 HRC	55 HRC	110	6.60
-70HT	...	480	550		<1.0	130	0.27	9	1030		26	55	160	6.80
-90HT	...	620	690		<1.0	140	0.27	12	1310		31	55	230	7.00
-110HT	...	760	830		<1.0	155	0.28	19	1590		37	55	290	7.20
FLNC-4408-60HT	...	410	480	[D]	<1.0	115	0.25	5	1100	520	18 HRC	55 HRC	120	6.60
-85HT	...	590	660		<1.0	130	0.27	9	1310	590	21	55	180	6.80
-105HT	...	720	790		<1.0	140	0.27	16	1520	660	25	55	230	7.00
-130HT	...	900	970		1.0	155	0.28	22	1720	720	30	55	290	7.20

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.
[E] Additional data in preparation will appear in subsequent editions of this standard.

TABLE X1.15 Diffusion Alloyed Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2).
NOTE 2—1 in. = 25.4 mm.
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy[C]	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival[C]	Density
	Yield	Ultimate[D]	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
FD-0205-45	45	...	68	52	1.0	18.0	0.27	8.0	130	47	72 HRB		24	6.75
-50	50	...	78	57	1.5	20.0	0.27	12.0	155	52	76	N/D	29	6.95
-55	55	...	88	61	2.0	22.0	0.28	18.0	180	57	80		32	7.15
-60	60	...	100	67	2.0	24.5	0.28	28.0	210	62	86		37	7.40
FD-0205-95HT	...	95	105	[E]	<1.0	18.0	0.27	5.0	160	130	28 HRC	55 HRC	42	6.75
-120HT	...	120	130		<1.0	20.0	0.27	7.0	190	155	33	55	52	6.95
-140HT	...	140	150		<1.0	22.0	0.28	9.0	210	175	38	55	65	7.15
-160HT	...	160	170		<1.0	24.5	0.28	11.0	240	200	45	55	75	7.40
FD-0208-50	50	...	69	58	<1.0	18.0	0.27	7.0	135	58	80 HRB		24	6.75
-55	55	...	79	63	<1.0	19.5	0.27	9.0	155	62	83	N/D	33	6.90
-60	60	...	92	68	1.0	21.5	0.27	12.0	180	67	87		38	7.10
-65	65	...	103	73	1.0	23.0	0.28	17.0	195	72	90		46	7.25
FD-0405-55	55	...	86	62	1.0	18.0	0.27	11.0	160	56	80 HRB		25	6.75
-60	60	...	103	66	1.0	21.0	0.27	20.0	195	63	85	N/D	28	7.05
-65	65	...	123	70	2.5	24.0	0.28	27.0	230	73	91		40	7.35
FD-0405-100HT	...	100	110	[E]	<1.0	18.0	0.27	5.0	160	125	30 HRC	55 HRC	26	6.75
-130HT	...	130	140		<1.0	21.0	0.27	7.0	200	150	35	55	50	7.05
-155HT	...	155	165		<1.0	24.0	0.28	10.0	235	175	42	55	58	7.35
FD-0408-50	50	...	71	57	<1.0	17.5	0.25	9.0	130	62	85 HRB		22	6.70
-55	55	...	90	62	1.0	20.0	0.27	13.0	165	68	89	N/D	27	6.95
-60	60	...	110	67	1.5	22.5	0.28	18.0	200	73	93		38	7.20
-65	65	...	125	71	2.0	24.5	0.28	22.0	230	80	95		48	7.40

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Alloys containing copper additions may have lower impact and fatigue limit as compared to the values in the data tables.
[D] Tempering temperature for heat-treated (HT) materials: 177 °C (350 °F).
[E] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.16 Diffusion Alloyed Steel (SI)

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy[C]	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit 90 % Survival[C]	Density
	Yield	Ultimate[C]	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FD-0205-45	310	...	470	360	1.0	125	0.27	11	900	320	72 HRB		170	6.75
-50	340	...	540	390	1.5	140	0.27	16	1070	360	76	N/D	200	6.95
-55	380	...	610	420	2.0	150	0.28	24	1240	390	80		220	7.15
-60	410	...	690	460	2.0	170	0.28	38	1450	430	86		260	7.40
FD-0205-95HT	...	660	720	[D]	<1.0	125	0.27	7	1100	900	28 HRC	55 HRC	290	6.75
-120HT	...	830	900		<1.0	140	0.27	9	1310	1070	33	55	360	6.95
-140HT	...	970	1030		<1.0	150	0.28	12	1450	1210	38	55	450	7.15
-160HT	...	1100	1170		<1.0	170	0.28	15	1650	1380	45	55	520	7.40
FD-0208-50	340	...	480	400	<1.0	125	0.27	9	930	400	80 HRB		170	6.75
-55	380	...	540	430	<1.0	135	0.27	12	1070	430	83	N/D	230	6.90
-60	410	...	630	470	1.0	150	0.27	16	1240	460	87		260	7.10
-65	450	...	710	500	1.0	160	0.28	23	1340	500	90		320	7.25
FD-0405-55	380	...	590	430	1.0	125	0.27	15	1100	390	80 HRB		170	6.75
-60	410	...	710	460	1.0	145	0.27	27	1340	430	85	N/D	200	7.05
-65	450	...	850	480	2.5	165	0.28	37	1590	500	91		280	7.35
FD-0405-100HT	...	690	760	[D]	<1.0	125	0.27	7	1100	860	30 HRC	55 HRC	180	6.75
-130HT	...	900	970		<1.0	145	0.27	9	1380	1030	35	55	340	7.05
-155HT	...	1070	1140		<1.0	165	0.28	14	1620	1210	42	55	400	7.35
FD-0408-50	340	...	490	390	<1.0	120	0.25	12	900	430	85 HRB		150	6.70
-55	380	...	620	430	1.0	140	0.27	18	1140	470	89	N/D	190	6.95
-60	410	...	760	460	1.5	155	0.28	24	1380	500	93		260	7.20
-65	450	...	860	490	2.0	170	0.28	30	1590	550	95		330	7.40

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat-treated (HT) materials: 177 °C (350 °F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

Alloys containing copper additions may have lower impact and fatigue limit as compared to the values in the data tables.
N/D—Not Determined for the purposes of this standard.

TABLE X1.17 Austenitic Stainless Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2)
NOTE 2—1 in. = 25.4 mm
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties															
	Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A]		Minimum Elongation (in 1 in.)	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		10^7 Cycle Fatigue Strength 90 % Survival	Density
	Yield	Ultimate		Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		%	10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
SS-303N1-25	25	…	0.0	39	32	0.5	15.5	0.25	3.5	86	38	62 HRB	N/D	13	6.4
SS-303N2-35	35	…	3.0	55	42	5.0	16.5	0.25	19.0	98	46	63 HRB	N/D	16	6.5
SS-303N2-38	38	…	6.0	68	45	10.0	20.0	0.27	35.0	N/D	46	70 HRB	N/D	21	6.9
SS-303L-12	12	…	12.0	39	17	17.5	17.0	0.25	40.0	82	21	21 HRB	N/D	15	6.6
SS-303L-15	15	…	15.0	48	24	20.0	20.0	0.27	55.0	N/D	29	35 HRB	N/D	19	6.9
SS-304N1-30	30	…	0.0	43	38	0.5	15.5	0.25	4.0	112	38	61 HRB	N/D	15	6.4
SS-304N2-33	33	…	5.0	57	40	10.0	16.5	0.25	25.0	127	47	62 HRB	N/D	18	6.5
SS-304N2-38	38	…	8.0	70	45	13.0	20.0	0.27	55.0	N/D	47	68 HRB	N/D	23	6.9
SS-304H-20	20		7.0	40	25	10	17.0	0.25	20.0	85	25	35 HRB	N/D	[C]	6.6
SS-304L-13	13	…	15.0	43	18	23.0	17.0	0.25	45.0	N/D	22	30 HRB	N/D	17	6.6
SS-304L-18	18	…	18.0	57	26	26.0	20.0	0.27	80.0	N/D	28	45 HRB	N/D	21	6.9
SS-316N1-25	25	…	0.0	41	34	0.5	15.5	0.25	5.0	108	36	59 HRB	N/D	11	6.4
SS-316N2-33	33	…	5.0	60	39	10.0	16.5	0.25	28.0	125	44	62 HRB	N/D	14	6.5
SS-316N2-38	38	…	8.0	70	45	13.0	20.0	0.27	48.0	N/D	46	65 HRB	N/D	19	6.9
SS-316H-20	20		5.0	35	25	7.0	17.0	0.25	20.0	85	25	33 HRB	N/D	[C]	6.6
SS-316L-15	15	…	12.0	41	20	18.5	17.0	0.25	35.0	80	22	20 HRB	N/D	13	6.6
SS-316L-22	22	…	15.0	57	30	21.0	20.0	0.27	65.0	N/D	29	45 HRB	N/D	17	6.9

N1—Nitrogen alloyed. Good strength, low elongation.
*Sintered at 2100°F (1149°C) in dissociated ammonia.
N2—Nitrogen alloyed. High strength, medium elongation.
*Sintered at 2350°F (1288°C) in dissociated ammonia
H—Low carbon. Lower strength, high elongation.
*Sintered at 2100°F (1149°C) in 100 % hydrogen.
L—Low carbon. Lower strength, highest elongation.
Sintered at 2350°F (1288°C) in partial vacuum.
Cooled to avoid nitrogen absorption.
*Processing parameters used to generate these data, other conditions could be used.

SS-303 *Austenitic Machining Grades*-SS-303 is preferred for parts requiring extensive secondary machining. Strength and hardness are high and corrosion resistance is good. SS-303 is non-magnetic.

SS-304 *General Purpose Austenitic Grades*-SS-304 has good strength properties and corrosion resistance. A general purpose grade used in many applications. SS-304 is non-magnetic.

SS-316 *General Purpose Austenitic Grades*-SS-316 has the best combination of properties in a P/M stainless steel alloy. Corrosion resistance is better than SS-303. First choice for general purpose applications. Non-magnetic.

[A] Suffix numbers represent *minimum* strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Additional data in preparation will appear in subsequent editions of this standard.

N/D—Not Determined for the purposes of this standard.

TABLE X1.18 Austenitic Stainless Steel (SI)

P/M Material Properties															
	Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A]		Minimum Elongation (in 25.4 mm)	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		10^7 Cycle Fatigue Strength 90 % Survival	Density
	Yield	Ultimate		Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		%	MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
SS-303N1-25	170	…	0.0	270	220	0.5	105	0.25	5	590	260	62 HRB	N/D	90	6.4
SS-303N2-35	240	…	3.0	380	290	5.0	115	0.25	26	680	320	63 HRB	N/D	110	6.5
SS-303N2-38	260	…	6.0	470	310	10.0	140	0.27	47	N/D	320	70 HRB	N/D	145	6.9
SS-303L-12	80	…	12.0	270	120	17.5	120	0.25	54	570	140	21 HRB	N/D	105	6.6
SS-303L-15	100	…	15.0	330	170	20.0	140	0.27	75	N/D	200	35 HRB	N/D	130	6.9
SS-304N1-30	210	…	0.0	300	260	0.5	105	0.25	5	770	260	61 HRB	N/D	105	6.4
SS-304N2-33	230	…	5.0	390	280	10.0	115	0.25	34	880	320	62 HRB	N/D	125	6.5
SS-304N2-38	260	…	8.0	480	310	13.0	140	0.27	75	N/D	320	68 HRB	N/D	160	6.9
SS-304H-20	140		7.0	280	170	10.0	120	0.25	27	590	170	35 HRB	N/D	[C]	6.6
SS-304L-13	90	…	15.0	300	120	23.0	120	0.25	61	N/D	150	30 HRB	N/D	115	6.6
SS-304L-18	120	…	18.0	390	180	26.0	140	0.27	108	N/D	190	45 HRB	N/D	145	6.9
SS-316N1-25	170	…	0.0	280	230	0.5	105	0.25	7	740	250	59 HRB	N/D	75	6.4
SS-316N2-33	230	…	5.0	410	270	10.0	115	0.25	38	860	300	62 HRB	N/D	95	6.5
SS-316N2-38	260	…	8.0	480	310	13.0	140	0.27	65	N/D	320	65 HRB	N/D	130	6.9
SS-316H-20	140		5.0	240	170	7.0	120	0.25	27	590	170	33 HRB	N/D	[C]	6.6
SS-316L-15	100	…	12.0	280	140	18.5	120	0.25	47	550	150	20 HRB	N/D	90	6.6
SS-316L-22	150	…	15.0	390	210	21.0	140	0.27	88	N/D	200	45 HRB	N/D	115	6.9

N1—Nitrogen alloyed. Good strength, low elongation.
*Sintered at 1149°C (2100°F) in dissociated ammonia
N2—Nitrogen alloyed. High strength, medium elongation.
*Sintered at 1288°C (2350°F) in dissociated ammonia
H—Low carbon. Lower strength, high elongation.
*Sintered at 1149°C (2100°F) in 100 % hydrogen.
L—Low carbon. Lower strength, highest elongation.
Sintered at 1288°C (2350°F) in partial vacuum.
Cooled to avoid nitrogen absorption.
*Processing parameters used to generate these data, other conditions could be used.

SS-303 *Austenitic Machining Grades*-SS-303 is preferred for parts requiring extensive secondary machining. Strength and hardness are high and corrosion resistance is good. SS-303 is non-magnetic.

SS-304 *General Purpose Austenitic Grades*-SS-304 has good strength properties and corrosion resistance. A general purpose grade used in many applications. SS-304 is non-magnetic.

SS-316 *General Purpose Austenitic Grades*-SS-316 has the best combination of properties in a P/M stainless steel alloy. Corrosion resistance is better than SS-303. First choice for general purpose applications. Non-magnetic.

[A] Suffix numbers represent minimum strength values in 10^3 psi (see page 2); yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Additional data in preparation will appear in subsequent editions of this standard.

N/D Not Determined for the purposes of this standard.

TABLE X1.19 Ferritic and Martensitic Stainless Steel

NOTE 1—10^3 psi = 6.895 MPa (6.895 N/mm^2)
NOTE 2—1 in. = 25.4 mm
NOTE 3—1 ft-lbf = 1.356 J.

P/M Material Properties																
	Minimum Values[A]			Typical Values[B]												
Material Designation Code	Minimum Strength[A]		Minimum Elongation (in 1 in.)	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		10^7 Cycle Fatigue Strength 90 % Survival	Density
	Yield	Ultimate[C]		Ultimate Strength	Yield Strength (0.2 %)[D]	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	10^3 psi		%	10^3 psi	10^3 psi	%	10^6 psi		ft-lbf	10^3 psi	10^3 psi	Rockwell		10^3 psi	g/cm^3
SS-410-90HT	…	90	0.0	105	[D]	<0.5	18.0	0.25	2.5	113	93	23 HRC	55 HRC	35	6.5
SS-410L-20	20	…	10.0	48	26	16.0	24.0	0.27	50	N/D	28	45 HRB	N/D	18	6.9
SS-430N2-28	28	…	3.0	60	35	5.0	25.0	0.27	25	N/D	33	70 HRB	N/D	25	7.1
SS-430L-24	24	…	14.0	50	30	20.0	25.0	0.27	80	N/D	33	45 HRB	N/D	25	7.1
SS-434N2-28	28	…	4.0	60	35	8.0	24.0	0.27	15	N/D	33	65 HRB	N/D	22	7.0
SS-434L-24	24	…	10.0	50	30	15.0	24.0	0.27	65	N/D	33	50 HRB	N/D	22	7.0

N2—Nitrogen alloyed. High strength, medium elongation.
*Sintered at 2350°F (1288°C) in dissociated ammonia
L—Low carbon. Lower strength, highest elongation.
Sintered at 2350°F (1288°C) in partial vacuum.
Cooled to avoid nitrogen absorption.
HT—Martensitic grade, heat treated. Highest strength.
*Sintered at 2100°F (1149°C) in dissociated ammonia.
*Processing parameters used to generate these data, other conditions could be used.

SS-409L *Standard Ferritic Grade*-SS-409 is used in applications requiring welding.

SS410-90HT Standard Martensitic Grade-SS-410 is used in applications requiring hardness and wear resistance. Carbon is added for increased heat treatment response. As-sintered, it is in a hardened state due to the effect of furnace cooling. A secondary quench and temper heat treatment will give increased hardness. It has fair corrosion resistance and poor machinability in comparison to the 300 series SS grades. SS-410 is ferromagnetic.

SS-410L *Standard Ferritic Grade*-SS-410 is used for soft magnetic properties and environments requiring the least corrosion resistance in a ferritic grade.

SS-430 *Standard Ferritic Grade*-SS-430 is used for soft magnetic properties and environments requiring somewhat better corrosion resistance than SS-410. Magnetic response lower than seen with SS-410

SS-434 *Standard Ferritic Grade*-SS-434 is used for soft magnetic properties and environments requiring slightly better corrosion resistance than SS-430. Magnetic response is similar to SS-430

[A] Suffix numbers represent *minimum* strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat treated (HT) material; 350°F (177°C).
[D] Yield and ultimate tensile strength are approximately the same for heat treated materials.

N/D—Not Determined for the purposes of this standard.

TABLE X1.20 Ferritic and Martensitic Stainless Steel (SI)

Material Designation Code	P/M Material Properties														
	Minimum Values[A]			Typical Values[B]											
	Minimum Strength[A,C]		Minimum Elongation (in 25.4 mm)	Tensile Properties			Elastic Constants		Unnotched Charpy Impact Energy	Transverse Rupture Strength	Compressive Yield Strength (0.1 %)	Hardness		10^7 Cycle Fatigue Strength 90 % Survival	Density
	Yield	Ultimate		Ultimate Strength	Yield Strength (0.2 %)[D]	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Microindentation (converted)		
	MPa		%	MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
SS-410-90HT	…	620	0.0	720	(D)	<0.5	125	0.25	3	780	640	23 HRC	55 HRC	240	6.5
SS-410L-20	140	…	10.0	330	180	16.0	165	0.27	68	N/D	190	45 HRB	N/D	125	6.9
SS-430N2-28	190	…	3.0	410	240	5.0	170	0.27	34	N/D	230	70 HRB	N/D	170	7.1
SS-430L-24	170	…	14.0	340	210	20.0	170	0.27	108	N/D	230	45 HRB	N/D	170	7.1
SS-434N2-28	190	…	4.0	410	240	8.0	165	0.27	20	N/D	230	68 HRB	N/D	150	7.0
SS-434L-24	170	…	10.0	340	210	15.0	165	0.27	88	N/D	230	50 HRB	N/D	150	7.0

N2—Nitrogen alloyed. High strength, medium elongation.
*Sintered at 1288°C (2350°F) in dissociated ammonia
L—Low carbon. Lower strength, highest elongation.
Sintered at 1288°C (2350°F) in partial vacuum.
Cooled to avoid nitrogen absorption.
HT—Martensitic grade, heat treated. Highest strength.
*Sintered at 1149°C (2100°F) in dissociated ammonia
*Processing parameters used to generate these data, other conditions could be used.

SS-409L *Standard Ferritic Grade*-SS-409 is used in applications requiring welding.

SS410-90HT *Standard Martensitic Grade*-SS-410 is used in applications requiring hardness and wear resistance. Carbon is added for increased heat treatment response. As-sintered, it is in a hardened state due to the effect of furnace cooling. A secondary quench and temper heat treatment will give increased hardness. It has poor corrosion resistance and poor machinability in comparison to the 300 series SS grades. SS-410 is ferromagnetic.

SS-410L *Standard Ferritic Grade*-SS-410L is used for soft magnetic properties and environments requiring the least corrosion resistance in a ferritic grade.

SS-430L *Ferritic Grade*-SS-430L is used for soft magnetic properties and environments requiring somewhat better corrosion resistance than SS-410L. Magnetic response is lower than seen with SS-410L.

SS-434L *Ferritic Grade*-SS-434L is used for soft magnetic properties and environments requiring slightly better corrosion resistance than SS-430L. Magnetic response is similar to SS-430L.

[A] Suffix numbers represent minimum strength values in 10^3 psi; yield in the as-sintered condition and ultimate in the heat-treated condition.
[B] Mechanical property data derived from laboratory prepared test specimens sintered under commercial manufacturing conditions.
[C] Tempering temperature for heat treated (HT) material; 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat treated materials.

N/D Not Determined for the purposes of this standard.