Designation: B 783 – 99ε1

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.

ε[1] NOTE—Editorial changes were made to this standard in March 2000.

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 yield strength for parts in the as-sintered condition, and minimum ultimate tensile strength for materials in the heat-treated condition.

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

NOTE 1—Paragraphs 5.1 and 7.1 will govern material classification by the designation code. The classification system is explained in Appendix X1.

2. Referenced Documents

2.1 *ASTM Standards:*

B 243 Terminology of Powder Metallurgy[2]

B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings[2]

E 8 Test Methods for Tension Testing of Metallic Materials[3]

2.2 *Other Standard:*

MPIF Standard 35 Materials Standard for P/M Structural Parts[4]

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 to this specification shall be ordered by materials 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 any method agreed upon by the manufacturer and the purchaser.

7. Physical Properties

7.1 *Density*:

7.1.1 The buyer and seller may agree upon a minimum average density for the part and minimum densities for specific regions of the part.

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

7.2 *Porosity*:

7.2.1 The buyer and seller should agree upon a minimum volume oil content for parts that are to be self-lubricating.

7.2.2 The buyer and seller 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.

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[1] This specification is under the jurisdiction of ASTM Committee B-9 on Metal Powder and Metal Powder Products and is the direct responsibility of Subcommittee B09.05 on Structural Parts.

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[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

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

TABLE 1 Chemical Requirements

Material Designation		Chemical Composition, Weight %											
		Iron	Copper	Carbon	Nickel	Molybdenum	Chromium	Manganese	Silicon	Sulfur	Phosphorus	Nitrogen	Columbium	Other
F-0000	Min	97.7	...	0.0	...	...	...	...	...	...	...	...	...	...
F-0000	Max	100.0	...	0.3	...	...	...	...	...	...	...	...	...	2.0
F-0005	Min	97.4	...	0.3	...	...	...	...	...	...	...	...	...	...
F-0005	Max	99.7	...	0.6	...	...	...	...	...	...	...	...	...	2.0
F-0008	Min	97.1	...	0.6	...	...	...	...	...	...	...	...	...	...
F-0008	Max	99.4	...	0.9	...	...	...	...	...	...	...	...	...	2.0
FX-1000	Min	82.8	8.0	0.0	...	...	...	...	...	...	...	...	...	...
FX-1000	Max	92.0	14.9	0.3	...	...	...	...	...	...	...	...	...	2.0
FX-1005	Min	82.5	8.0	0.3	...	...	...	...	...	...	...	...	...	...
FX-1005	Max	91.7	14.9	0.6	...	...	...	...	...	...	...	...	...	2.0
FX-1008	Min	82.2	8.0	0.6	...	...	...	...	...	...	...	...	...	...
FX-1008	Max	91.4	14.9	0.9	...	...	...	...	...	...	...	...	...	2.0
FX-2000	Min	72.7	15.0	0.0	...	...	...	...	...	...	...	...	...	...
FX-2000	Max	85.0	25.0	0.3	...	...	...	...	...	...	...	...	...	2.0
FX-2005	Min	72.4	15.0	0.3	...	...	...	...	...	...	...	...	...	...
FX-2005	Max	84.7	25.0	0.6	...	...	...	...	...	...	...	...	...	2.0
FX-2008	Min	72.1	15.0	0.6	...	...	...	...	...	...	...	...	...	...
FX-2008	Max	84.4	25.0	0.9	...	...	...	...	...	...	...	...	...	2.0
FC-0200	Min	93.8	1.5	0.0	...	...	...	...	...	...	...	...	...	...
FC-0200	Max	98.5	3.9	0.3	...	...	...	...	...	...	...	...	...	2.0
FC-0205	Min	93.5	1.5	0.3	...	...	...	...	...	...	...	...	...	...
FC-0205	Max	98.2	3.9	0.6	...	...	...	...	...	...	...	...	...	2.0
FC-0208	Min	93.2	1.5	0.6	...	...	...	...	...	...	...	...	...	...
FC-0208	Max	97.9	3.9	0.9	...	...	...	...	...	...	...	...	...	2.0
FC-0505	Min	91.4	4.0	0.3	...	...	...	...	...	...	...	...	...	...
FC-0505	Max	95.7	6.0	0.6	...	...	...	...	...	...	...	...	...	2.0
FC-0508	Min	91.1	4.0	0.6	...	...	...	...	...	...	...	...	...	...
FC-0508	Max	95.4	6.0	0.9	...	...	...	...	...	...	...	...	...	2.0
FC-0808	Min	88.1	7.0	0.6	...	...	...	...	...	...	...	...	...	...
FC-0808	Max	92.4	9.0	0.9	...	...	...	...	...	...	...	...	...	2.0
FC-1000	Min	87.2	9.5	0.0	...	...	...	...	...	...	...	...	...	...
FC-1000	Max	90.5	10.5	0.3	...	...	...	...	...	...	...	...	...	2.0
FN-0200	Min	92.2	0.0	0.0	1.0	...	...	...	...	...	...	...	...	...
FN-0200	Max	99.0	2.5	0.3	3.0	...	...	...	...	...	...	...	...	2.0
FN-0205	Min	91.9	0.0	0.3	1.0	...	...	...	...	...	...	...	...	...
FN-0205	Max	98.7	2.5	0.6	3.0	...	...	...	...	...	...	...	...	2.0
FN-0208	Min	91.6	0.0	0.6	1.0	...	...	...	...	...	...	...	...	...
FN-0208	Max	98.4	2.5	0.9	3.0	...	...	...	...	...	...	...	...	2.0
FN-0405	Min	89.9	0.0	0.3	3.0	...	...	...	...	...	...	...	...	...
FN-0405	Max	96.7	2.0	0.6	5.5	...	...	...	...	...	...	...	...	2.0
FN-0408	Min	89.6	0.0	0.6	3.0	...	...	...	...	...	...	...	...	...
FN-0408	Max	96.4	2.0	0.9	5.5	...	...	...	...	...	...	...	...	2.0
FL-4205	Min	95.9	...	0.4	0.35	0.50	...	...	...	...	...	...	...	...
FL-4205	Max	98.75	...	0.7	0.55	0.85	...	...	...	...	...	...	...	2.0
FL-4605	Min	94.5	...	0.4	1.70	0.40	...	...	...	...	...	...	...	...
FL-4605	Max	97.5	...	0.7	2.00	0.80	...	...	...	...	...	...	...	2.0

TABLE 1 *Continued*

Material Designation		Chemical Composition, Weight %												
		Iron	Copper	Carbon	Nickel	Molybdenum	Chromium	Manganese	Silicon	Sulfur	Phosphorus	Nitrogen	Columbium	Other
FL-4405	Min	96.35	...	0.4		0.75	...	...	...	...	...	...	...	...
FL-4405	Max	98.85	...	0.7		0.95	...	...	...	...	...	...	...	2.0
FLN-4205	Min	93.95	...	0.4	1.35*	0.49	...	...	...	...	...	...	...	...
FLN-4205	Max	97.76	...	0.7	2.5*	0.85	...	...	...	...	...	...	...	2.0
FLN2-4405	Min	93.35	...	0.4	1.00	0.65	...	...	...	...	...	...	...	...
FLN2-4405	Max	97.95	...	0.7	3.00	0.95	...	...	...	...	...	...	...	2.0
FLN4-4405	Min	91.35	...	0.4	3.00	0.65	...	...	...	...	...	...	...	...
FLN4-4405	Max	95.95	...	0.7	5.00	0.95	...	...	...	...	...	...	...	2.0
FLN6-4405	Min	89.35	...	0.4	5.00	0.65	...	...	...	...	...	...	...	...
FLN6-4405	Max	93.95	...	0.7	7.00	0.95	...	...	...	...	...	...	...	2.0
FLNC-4405	Min	90.35	1.0	0.4	1.00	0.65	...	...	...	...	...	...	...	...
FLNC-4405	Max	96.95	3.0	0.7	3.00	0.95	...	...	...	...	...	...	...	2.0
FLN2-4408	Min	93.15	...	0.6	1.00	0.65	...	...	...	...	...	...	...	...
FLN2-4408	Max	97.75	...	0.9	3.00	0.95	...	...	...	...	...	...	...	2.0
FLN4-4408	Min	91.15	...	0.6	3.00	0.65	...	...	...	...	...	...	...	...
FLN4-4408	Max	95.75	...	0.9	5.00	0.95	...	...	...	...	...	...	...	2.0
FLN6-4408	Min	89.15	...	0.6	5.00	0.65	...	...	...	...	...	...	...	...
FLN6-4408	Max	93.75	...	0.9	7.00	0.95	...	...	...	...	...	...	...	2.0
FLN-4608	Min	91.00	...	0.6	3.6**	0.39	...	...	...	...	...	...	...	...
FLN-4608	Max	93.41	...	0.9	5.0**	1.10	...	...	...	...	...	...	...	2.0
FLC-4608	Min	91.00	1.0	0.6	1.60	0.39	...	...	...	...	...	...	...	...
FLC-4608	Max	96.41	3.0	0.9	2.00	1.10	...	...	...	...	...	...	...	2.0
FLC-4908	Min	92.40	1.0	0.6	...	1.30	...	...	...	...	...	...	...	...
FLC-4908	Max	95.10	3.0	0.9	...	1.70	...	...	...	...	...	...	...	2.0
FLNC-4408	Min	90.15	1.0	0.6	1.00	0.65	...	...	...	...	...	...	...	...
FLNC-4408	Max	96.75	3.0	0.9	3.00	0.95	...	...	...	...	...	...	...	2.0
FD-0205	Min	93.15	1.3	0.3	1.55	0.4	...	...	...	...	...	...	...	...
FD-0205	Max	96.45	1.7	0.6	1.95	0.6	...	...	...	...	...	...	...	2.0
SS-303N1,N2	Min	Rem	...	0	8.0	...	17.0	0	0	0.15	0	0.2	...	...
SS-303N1,N2	Max	Rem	...	0.15	13.0	...	19.0	2.0	1.0	0.30	0.20	0.6	...	2.0
SS-303L	Min	Rem	...	0	8.0	...	17.0	0	0	0.15	0	...	...	...
SS-303L	Max	Rem	...	0.03	13.0	...	19.0	2.0	1.0	0.30	0.20	...	...	2.0
SS-304N1,N2	Min	Rem	...	0	8.0	...	18.0	0	0	0	0	0.2	...	...
SS-304N1,N2	Max	Rem	...	0.08	12.0	...	20.0	2.0	1.0	0.03	0.045	0.6	...	2.0
SS-304L	Min	Rem	...	0	8.0	...	18.0	0	0	0	0	...	...	...
SS-304L	Max	Rem	...	0.03	12.0	...	20.0	2.0	1.0	0.03	0.045	...	...	2.0
SS-316N1,N2	Min	Rem	...	0	10.0	2.0	16.0	0	0	0	0	0.2	...	...
SS-316N1,N2	Max	Rem	...	0.08	14.0	3.0	18.0	2.0	1.0	0.03	0.045	0.6	...	2.0
SS-316L	Min	Rem	...	0	10.0	2.0	16.0	0	0	0	0	...	...	...
SS-316L	Max	Rem	...	0.03	14.0	3.0	18.0	2.0	1.0	0.03	0.045	...	...	2.0
SS-410	Min	Rem	...	0	...	...	11.5	0	0	0	0	0.2	...	...
SS-410	Max	Rem	...	0.25	...	...	13.0	1.0	1.0	0.03	0.04	0.6	...	2.0

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.

8. Mechanical Properties

8.1 The minimum guaranteed tensile strength, as shown in Tables 2-7, is a numerical suffix in the material designation code and is read as 10^3 psi. The code is adopted from MPIF Standard 35. All tensile strengths are defined as the 0.2 % offset yield strength for as-sintered materials and the ultimate tensile strength for sinter-hardened or sintered and heat-treated materials.

8.1.1 Materials in the as-sintered condition will have only the numeric value for the suffix.

8.1.2 Materials that are sinter-hardened or sintered and heat-treated will have the numeric value followed by HT in the suffix.

8.2 The purchaser and manufacturer 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 may also be verified using specifically prepared bars, molded form 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.

8.3.1 Transverse rupture strength can be related to the minumum 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 Fig. 1) should be used for determination of 0.2 % offset yield strength.

8.3.3 For determining the tensile strength of heat-treated material, round test bars should be machined from specially molded, as-sintered bars because heat treated, unmachined specimens yield lower values, The machined tension test specimens as shown in Fig. 2 should be heat-treated with the production parts.

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 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 4 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)

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.

TABLE 5 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)

TABLE 6 Minimum Tensile Strength for Low Alloy Steel

Material Designation Code	Minimum Strength
	Ultimate
	10^3 psi[A]
FL-4205-80HT	80
-100HT	100
-120HT	120
-140HT	140
FL-4605-80HT	80
-100HT	100
-120HT	120
-140HT	140

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

9.3 *Mechanical Tests*—The manufacturer and purchaser shall agree on a representative number of specimens for mechanical tests.

10. Rejection and Rehearing

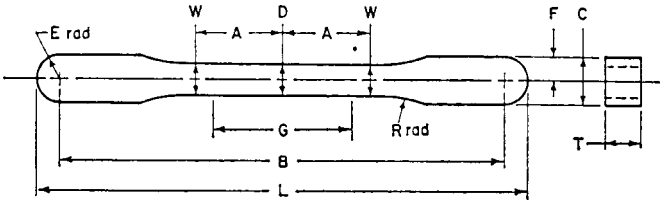
10.1 Parts that fail to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing.

TABLE 7 Minimum Tensile Strength for Stainless Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
SS-303N1-25	25	...
SS-303N2-35	35	...
SS-303L-12	12	...
SS-304N1-30	30	...
SS-304N2-33	33	...
SS-304L-13	13	...
SS-316N1-25	25	...
SS-316N2-33	33	...
SS-316L-15	15	...
SS-410-90HT	...	90

[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.



Pressing Area = 1.00 in.^{2}

Note—Dimensions specified, except G and T are those of the die.

Dimensions

	in.	mm
A—Half length of reduced section	0.625 ± 0.001	15.88
B—Grip length	3.187 ± 0.001	80.95 ± 0.03
C—Width of grip section	0.343 ± 0.001	8.71 ± 0.03
D—Width at center	0.225 ± 0.001	5.72 ± 0.03
E—End radius	0.171 ± 0.001	4.34 ± 0.03
F—Half width of grip section	0.171 ± 0.001	4.34 ± 0.03
G—Gage length	1.000 ± 0.003	25.40 ± 0.08
L—Overall length	3.529 ± 0.001	89.64 ± 0.03
R—Radius of fillet	1	25.4
T—Compact to this thickness	0.140 to 0.250	3.56 to 6.35
W—Width at end of reduced section	0.235 ± 0.001	5.97 ± 0.03

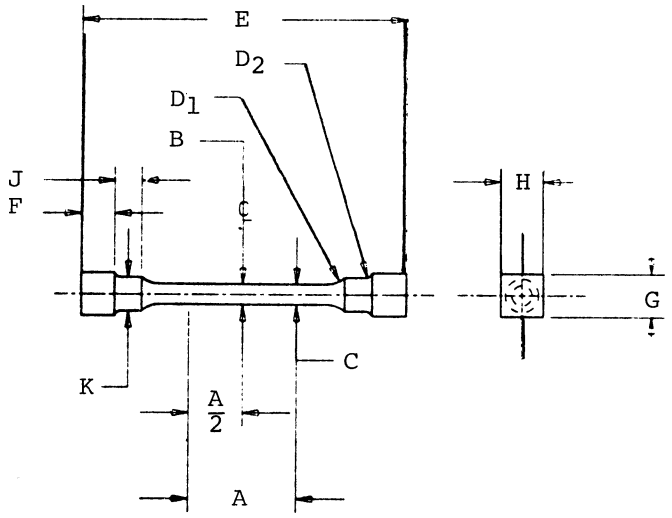
FIG. 1 Standard Flat Unmachined Tension Test Specimen for Powder Metallurgy (P/M) Products

11. Certification

11.1 When specified in the purchase order or contract, a producer's certification shall be furnished to the purchaser 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.

12. Keywords

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



Dimensions

	in.	mm
A—Gage length	1.000 ± 0.003	25.40 ± 0.08
B—Diameter at center of reduced section	0.187 ± 0.001	4.75 ± 0.03
C—Diameter at ends of gage length	0.191 ± 0.001	4.85 ± 0.03
D_1—Radius of fillet	0.250 ± 0.005	6.35 ± 0.13
D_2—Radius of fillet	0.050 ± 0.005	1.27 ± 0.13
E—Overall length (die cavity length)	3 Nominal	75 Nominal
F—Length of end section	0.310 ± 0.005	7.88 ± 0.13
G—Compact to this end thickness	0.395 ± 0.005	10.03 ± 0.13
H—Die cavity width	0.395 ± 0.003	10.03 ± 0.08
J—Length of shoulder	0.250 ± 0.005	6.35 ± 0.13
K—Diameter of shoulder	0.310 ± 0.001	7.88 ± 0.03

NOTE 1—Diameters to be concentric within 0.001 T.I.R. and the 0.191 and 0.187 diameters to be free of scratches and tool marks.

FIG. 2 Standard Round Machined Tension Test Specimen for Powder Metallurgy (P/M) Products

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 chemistry and minimum strength expressed in 10^3 psi (6.895 MPa). For example, FC-0208-60 is a P/M copper steel material containing nominal 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 chemistry 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 longer a requirement of the specification.

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 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 steels. The prefix letter codes are as follows:

X1.1.4.1 C—Copper.

X1.1.4.2 F—Iron.

X1.1.4.3 FC—Iron Copper and Copper Steel.

X1.1.4.4 FN—Iron Nickel and Nickel Steel.

X1.1.4.5 FX—Infiltrated Iron or Steel.

X1.1.4.6 FL—Prealloyed Ferrous material except Stainless Steel.

X1.1.4.7 FLN, FLNC, or FLC Prealloyed Low Alloy Steel Power, with Elemental Additions.

X1.1.4.8 FD—Diffusion Alloyed Steel.

X1.1.4.9 M—Manganese.

X1.1.4.10 N—Nickel.

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.

X1.2.2 Combined carbon content in ferrous materials is designated by the last two numbers in the four-digit series. The carbon content up to and including 0.3 % is considered as zero; higher contents are included in ranges and coded as follows:

Carbon Ranges	Code Designation
from 0.0 % to 0.3 %	00
from 0.3 % to 0.6 %	05
from 0.6 % to 0.9 %	08

X1.2.3 The range of carbon that is metallurgically combined is indicated in the coding system. For an illustration of P/M ferrous material designation coding see Fig. X1.1.

X1.2.4 In the case of P/M prealloyed low alloy steels, the four digit series is replaced with a designation derived from modifications of the American Iron and Steel Institute alloy coding system, e.g. FL-4605-100HT. As with other P/M materials, the suffix number denotes the specified minimum strength value expressed in 10^3 psi.

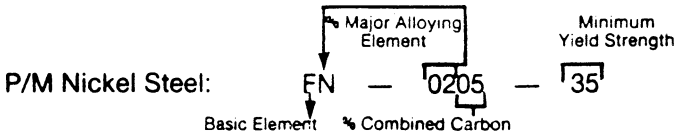


FIG. X1.1 Illustration of P/M Ferrous Material Designation Coding

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 chemistry. 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-X1.12).

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 (quenched and tempered) and that the strength represented is ultimate tensile in 10^3 psi (6.895 MPa (6.895 N/mm^2)).

X1.5 *Data Source*—Information used in compiling this specification was contributed by the membership of ASTM Committee B-9 on Metal Powders and Metal Powder Products and the Standards Committee of the Powder Metallurgy parts Association of MPIF. 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 X1.1 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-lb = 1.356 J.

P/M Material Properties															
Minimum Values[A]			Typical Values[B]												
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Transverse Rupture Strength	Unnotched Charpy Impact Strength	Density	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit[D]
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		10^3 psi	ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi
F-0000-10	10	...	18	13	1.5	14.0	[E]	36	3	6.1	[E]	40HRF		7
-15	15	...	25	18	2.5	17.0		50	6	6.7		60	N/A	10
-20	20	...	38	25	7.0	20.5		95	35	7.3		80		14
F-0005-15	15	...	24	18	<1.0	14.0	[E]	48	3	6.1	[E]	25HRB		9
-20	20	...	32	23	1.0	16.5		64	4	6.6		40	N/A	12
-25	25	...	38	28	1.5	18.0		76	5	6.9		55		14
F-0005-50HT	...	50	60	[F]	<0.5	16.5	[E]	105	3	6.6	[E]	20HRC	58HRC	23
-60HT	...	60	70		<0.5	17.5		120	3.5	6.8		22	58	27
-70HT	...	70	80		<0.5	19.0		140	4	7.0		25	58	30
F-0008-20	20	...	29	25	<0.5	12.0	[E]	51	2.5	5.8	[E]	35HRB		11
-25	25	...	35	30	<0.5	14.5		61	3	6.2		50	N/A	13
-30	30	...	42	35	<1.0	16.5		74	4	6.6		60		16
-35	35	...	57	40	1.0	19.0		100	5	7.0		70		22
F-0008-55HT	...	55	65	[F]	<0.5	15.0	[E]	100	3	6.3	[E]	22HRC	60HRC	25
-65HT	...	65	75		<0.5	16.5		115	4	6.6		28	60	29
-75HT	...	75	85		<0.5	18.0		130	4.5	6.9		32	60	32
-85HT	...	85	95		<0.5	19.5		145	5	7.1		35	60	36

[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] Fatigue limit values are estimates derived as 38 % of typical ultimate tensile strength and were not experimentally determined.
[E] Additional data in preparation will appear in subsequent editions of this standard.
[F] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

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)	Micro (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	40HRF		46	6.1
-15	100		170	120	2.5	120	0.25	8	340	210	60	N/A	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	200	25HRB		60	6.1
-20	140		220	160	1.0	115	0.25	5	440	210	40	N/A	80	6.6
-25	170		260	190	1.5	135	0.27	7	520	220	55		100	6.9
F-0005-50HT		340	410	[D]	<0.5	115	0.25	4	720	300	20HRC	58HRC	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	280	35HRB		80	5.8
-25	170		240	210	<0.5	110	0.25	4	420	280	50	N/A	100	6.2
-30	210		290	240	<1.0	115	0.25	5	510	290	60		120	6.6
-35	240		390	260	1.0	140	0.27	7	690	290	70		170	7.0
F-0008-55HT		380	450	[D]	<0.5	115	0.25	4	690	290	22HRC	60HRC	180	6.3
-65HT		450	520		<0.5	115	0.25	5	790	400	28	60	210	6.6
-75HT		520	590		<0.5	135	0.27	6	900	520	32	60	240	6.9
-85HT		590	660		<0.5	150	0.27	7	1000	590	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: 177°C (350°F).
[D] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

TABLE X1.3 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-lb = 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					Transverse Rupture Strength	Unnotched Charpy Impact Strength	Density	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit[D]
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		10^3 psi	ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi
FX-1000-25	25	...	51	32	7.0	16.0	[E]	132	25	7.3	[E]	65HRB	N/A	19
FX-1005-40	40	...	77	50	4.0	16.0	[E]	158	13	7.3	[E]	82HRB	N/A	29
FX-1005-110HT	...	110	120	[F]	<0.5	16.0	[E]	210	7	7.3	[E]	38HRC	55HRC	46
FX-1008-50	50	...	87	60	3.0	16.0	[E]	166	10	7.3	[E]	89HRB	N/A	33
FX-1008-110HT	...	110	120	[F]	<0.5	16.0	[E]	189	6.5	7.3	[E]	43HRC	58HRC	46
FX-2000-25	25	...	46	37	3.0	15.0	[E]	144	15	7.3	[E]	66HRB	N/A	17
FX-2005-45	45	...	75	60	1.5	15.0	[E]	148	8	7.3	[E]	85HRB	N/A	29
FX-2005-90HT	...	90	100	[F]	<0.5	15.0	[E]	171	7	7.3	[E]	36HRC	55HRC	38
FX-2008-60	60	...	80	70	1.0	15.0	[E]	156	7	7.3	[E]	90HRB	N/A	30
FX-2008-90HT	...	90	100	[F]	<0.5	15.0	[E]	159	5	7.3	[E]	36HRC	58HRC	38

[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] Fatigue limit values are estimates derived as 38 % of typical ultimate tensile strength and were not experimentally determined.
[E] Additional data in preparation will appear in subsequent editions of this standard.
[F] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

TABLE X1.4 Copper Infiltrated Iron and Steel (SI)

NOTE 1—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)	Micro (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	65HRB	N/A	133	7.3
FX-1005-40	280		530	340	4.0	160	0.28	18	1090	370	82HRB	N/A	200	7.3
FX-1005-110HT		760	830	[D]	<0.5	160	0.28	9	1450	760	38HRC	55HRC	230	7.3
FX-1008-50	340		600	410	3.0	160	0.28	14	1140	490	89HRB	N/A	230	7.3
FX-1008-110HT		760	830	[D]	<0.5	160	0.28	9	1300	790	43HRC	58HRC	280	7.3
FX-2000-25	170		320	260	3.0	145	0.24	20	990	280	66HRB	N/A	122	7.3
FX-2005-45	310		520	410	1.5	145	0.24	11	1020	410	85HRB	N/A	140	7.3
FX-2005-90HT		620	690	[D]	<0.5	145	0.24	9	1180	490	36HRC	55HRC	160	7.3
FX-2008-60	410		550	480	1.0	145	0.24	9	1080	480	90HRB	N/A	160	7.3
FX-2008-90HT		620	690	[D]	<0.5	145	0.24	7	1100	510	36HRC	58HRC	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).

TABLE X1.5 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-lb = 1.356 J.

P/M Material Properties														
Minimum Values[A]			Typical Values[B]											
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Transverse Rupture Strength	Unnotched Charpy Impact Strength	Density	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit[D]
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		10^3 psi	ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi
FC-0200-15	15	...	25	20	1.0	13.0	[E]	45	4.5	6.0	[E]	11HRB		10
-18	18	...	28	23	1.5	15.0		51	5	6.3		18	N/A	11
-21	21	...	31	26	1.5	16.5		56	5.5	6.6		26		12
-24	24	...	34	29	2.0	18.0		63	6	6.9		36		13
FC-0205-30	30	...	35	35	<1.0	13.0	[E]	60	<2	6.0	[E]	37HRB		13
-35	35	...	40	40	<1.0	15.0		75	3	6.3		48	N/A	15
-40	40	...	50	45	<1.0	17.0		95	5	6.7		60		19
-45	45	...	60	50	<1.0	19.5		115	8	7.1		72		23
FC-0205-60HT	...	60	70	[F]	<0.5	14.5	[E]	95	2.5	6.2	[E]	19HRC	58HRC	27
-70HT	...	70	80		<0.5	16.0		110	3.5	6.5		25	58	30
-80HT	...	80	90		<0.5	17.5		120	4.5	6.8		31	58	34
-90HT	...	90	100		<0.5	19.0		135	5.5	7.0		36	58	38
FC-0208-30	30	...	35	35	<1.0	12.0	[E]	60	<2	5.8	[E]	50HRB		13
-40	40	...	50	45	<1.0	15.0		90	2	6.3		61	N/A	19
-50	50	...	60	55	<1.0	17.0		125	5	6.7		73		23
-60	60	...	75	65	<1.0	20.0		155	7	7.2		84		29
FC-0208-50HT	...	50	65	[F]	<0.5	14.0	[E]	95	2.5	6.1	[E]	20HRC	60HRC	25
-65HT	...	65	75		<0.5	15.5		110	3.5	6.4		27	60	29
-80HT	...	80	90		<0.5	17.5		130	4.5	6.8		35	60	34
-95HT	...	95	105		<0.5	19.5		150	5.5	7.1		43	60	40
FC-0505-30	30	...	44	36	<0.5	12.0	[E]	77	3	5.8	[E]	51HRB		17
-40	40	...	58	47	<0.5	15.0		102	4.5	6.3		62	N/A	22
-50	50	...	71	56	<1.0	17.0		124	5	6.7		72		27
FC-0508-40	40	...	50	50	<0.5	12.5	[E]	100	3	5.9	[E]	60HRB		22
-50	50	...	68	60	<0.5	15.0		120	3.5	6.3		68	N/A	26
-60	60	...	82	70	<1.0	17.5		145	4.5	6.8		80		31
FC-0808-45	45	...	55	50	<0.5	13.0	[E]	85	3	6.0	[E]	65HRB	N/A	21
FC-1000-20	20	...	30	26	<1.0	13.0	[E]	53	3.5	6.0	[E]	15HRB	N/A	11

[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] Fatigue limit values are estimates derived as 38 % of typical ultimate tensile strength and were not experimentally determined.
[E] Additional data in preparation will appear in subsequent editions of this standard.
[F] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

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

P/M Material Properties310														
MINIMUM VALUES[A]			TYPICAL VALUES[B]											
Material Designation Code	Minimum Strength[A,C]		TENSILE PROPERTIES			ELASTIC CONSTANTS		Unnotched Charpy Impact Emergy	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)	Micro (converted)		
	MPa		MPa	MPa	%	GPa		J	MPa	MPa	Rockwell		MPa	g/cm^3
FC-0200-15	100		170	140	1.0	95	0.27	6	310	120	11HRB		70	6.0
-18	120		190	160	1.5	115	0.25	7	350	140	18	N/A	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	0.27	<3	410	340	37HRB		90	6.0
-35	240		280	280	<1.0	115	0.25	4	520	370	48	N/A	100	6.3
-40	280		340	310	<1.0	120	0.25	7	660	390	60		140	6.7
-45	310		410	340	<1.0	150	0.27	10	790	410	72		210	7.1
FC-0205-60HT		410	480	[D]	<0.5	110	0.25	3	660	390	19HRC	58HRC	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	390	50HRB		90	5.8
-40	280		340	310	<1.0	115	0.25	3	620	430	61	N/A	120	6.3
-50	340		410	380	<1.0	120	0.25	7	860	460	73		160	6.7
-60	410		520	450	<1.0	155	0.28	9	1070	490	84		230	7.2
FC-0208-50HT		340	450	[D]	<0.5	105	0.25	3	660	400	20HRC	60HRC	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	51HRB		114	5.8
-40	280		400	320	<0.5	115	0.25	6	700	370	62	N/A	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	60HRB		152	5.9
-50	340		470	410	<0.5	115	0.25	5	830	430	68	N/A	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	65HRB	N/A	144	6.0
FC-1000-20	140		210	180	<1.0	95	0.27	5	370	230	15HRB	N/A	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.

TABLE X1.7 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-lb = 1.356 J.

P/M Material Properties															
Minimum Values[A]			Typical Values[B]												
Material Designation Code	Minimum Strength[A,C]		Tensile Properties					Transverse Rupture Strength	Unnotched Charpy Impact Strength	Density	Compressive Yield Strength (0.1 %)	Hardness		Fatigue Limit[D]
	Yield	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi		10^3 psi	10^3 psi	%	10^6 psi		10^3 psi	ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi
FN-0200-15	15	...	25	17	1.5	15.5		[E]	[E]	6.6		[E]		10
-20	20	...	35	25	4.0	19.5	[E]	80	19.5	6.7	[E]	75HRF	N/A	13
-25	25	...	40	30	6.5	23.0		[E]	[E]	7.3		[E]		15
FN-0205-20	20	...	40	25	1.5	15.5		65	6.0	6.6		44HRB		15
-25	25	...	50	30	2.5	18.5		100	12.0	6.9		59		19
-30	30	...	60	35	4.0	22.0	[E]	125	21.0	7.2	[E]	69	N/A	23
-35	35	...	70	40	5.0	24.0		150	34.0	7.4		78		27
RN-0205-80HT	...	80	90		<0.5	15.5		120	3.5	6.6		23HRC	55HRC	34
-105HT	...	105	120		<0.5	18.5		160	4.5	6.9		29	55	46
-130HT	...	130	145	[F]	<0.5	21.0	[F]	190	6.0	7.1	[E]	33	55	55
-155HT	...	155	160		<0.5	22.0		215	7.0	7.2		36	55	61
-180HT	...	180	185		<0.5	24.0		250	9.5	7.4		40	55	70
FN-0208-30	30	...	45	35	1.5	16.5		85	5.5	6.7		63HRB		17
-35	35	...	55	40	1.5	18.5		105	8.0	6.9		71		21
-40	40	...	70	45	2.0	21.0	[E]	130	11.0	7.1	[E]	77	N/A	27
-45	45	...	80	50	2.5	23.0		155	16.0	7.3		83		30
-50	50	...	90	55	3.0	24.0		170	21.0	7.4		88		34
FN-0208-80HT	...	80	90		<0.5	16.5		120	4.0	6.7		26HRC	57HRC	34
-105HT	...	105	120		<0.5	18.5		150	4.5	6.9		31	57	46
-130HT	...	130	145	[F]	<0.5	19.5	[E]	185	5.5	7.0	[E]	35	57	55
-155HT	...	155	170		<0.5	22.0		220	7.0	7.2		39	57	65
-180HT	...	180	195		<0.5	24.0		250	8.0	7.4		42	57	74
FN-0405-25	25	...	40	30	<1.0	14.0		65	4.5	6.5		49HRB		15
-35	35	...	60	40	3.0	19.5	[E]	120	14.5	7.0	[E]	71	N/A	23
-45	45	...	90	50	4.5	24.0		175	33.5	7.4		84		34
FN-0405-80HT	...	80	85		<0.5	14.0		115	4.0	6.5		19HRC	55HRC	32
-105HT	...	105	110		<0.5	17.5		145	5.0	6.8		25	55	42
-130HT	...	130	135	[F]	<0.5	19.5	[E]	200	6.5	7.0	[E]	31	55	51
-155HT	...	155	160		<0.5	23.0		245	9.5	7.3		37	55	61
-180HT	...	180	185		<0.5	24.0		280	13.0	7.4		40	55	70
FN-0408-35	35	...	45	40	1.0	14.5		75	4.0	6.5		67HRB		17
-45	45	...	65	50	1.0	18.5	[E]	115	7.5	6.9	[E]	78	N/A	25
-55	55	...	80	60	1.0	22.0		150	11.0	7.2		87		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: 500°F (260°C).
[D] Fatigue limit values are estimates derived as 38 % of typical ultimate tensile strength and were not experimentally determined.
[E] Additional data in preparation will appear in subsequent editions of this standard.
[F] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

TABLE X1.8 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		Un-notched Charpy Impact Energy	Trans-verse Rupture Strength	Compres-sive 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 (ap-parent)	Micro (con-verted)		
	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	55HRF		70	6.6
-20	140		240	170	5.0	140	0.27	27	550	120	75	N/A	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	230	44HRB		100	6.6
-25	170		340	210	2.5	135	0.27	16	690	260	59		120	6.9
-30	210		410	240	4.0	155	0.28	28	860	290	69	N/A	150	7.2
-35	240		480	280	5.5	170	0.28	46	1030	310	78		180	7.4
FN-0205-80HT		550	620		<0.5	115	0.25	5	830	530	23HRC	55HRC	180	6.6
-105HT		720	830		<0.5	135	0.27	6	1110	620	29	55	240	6.9
-130HT		900	1000	[D]	<0.5	150	0.27	8	1310	680	33	55	290	7.1
-155HT		1070	1100		<0.5	155	0.28	9	1480	710	36	55	320	7.2
-180HT		1240	1280		<0.5	170	0.28	13	1720	770	40	55	370	7.4
FN-0208-30	210		310	240	1.5	120	0.25	7	590	280	63HRB		110	6.7
-35	240		380	280	1.5	135	0.27	11	720	320	71		140	6.9
-40	280		480	310	2.0	150	0.27	15	900	370	77	N/A	170	7.1
-45	310		550	340	2.5	160	0.28	22	1070	410	83		190	7.3
-50	340		620	380	3.0	170	0.28	28	1170	430	88		220	7.4
FN-0208-80HT		550	620		<0.5	120	0.25	5	830	680	26HRC	57HRC	200	6.7
-105HT		720	830		<0.5	135	0.27	6	1030	850	31	57	260	6.9
-130HT		900	1000	[D]	<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	40HRB		100	6.5
-35	240		410	280	3.0	140	0.27	20	830	280	71	N/A	150	7.0
-45	310		620	340	4.5	170	0.28	45	1210	310	84		220	7.4
FN-0405-80HT		550	590		<0.5	105	0.25	5	790	460	19HRC	55HRC	180	6.5
-105HT		720	760		<0.5	130	0.27	7	1000	610	25	55	230	6.8
-130HT		900	930	[D]	<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	67HRB		110	6.5
-45	310		450	340	1.0	135	0.27	10	790	340	78	N/A	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.

TABLE X1.9 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-lb = 1.356 J.

P/M Material Properties													
Minimum Values[A]		Typical Values[B]											
Material Designation Code[C]	Minimum Strength[A]	Tensile Properties					Transverse Rupture Strength	Un-notched Charpy Impact Strength	Density	Compres-sive Yield Strength (0.1 %)	Hardness		Fatigue Limit[D]
	Ultimate	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi	10^3 psi	%	10^6 psi	10^3 psi		ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi	
FL-4205-80HT	80	90	[E]	<0.5	17.0	[E]	135	3.5	6.60	[E]	28HRC	60HRC	34
-100HT	110	110		<0.5	19.0		160	4.0	6.80		32	60	42
-120HT	120	130		<0.5	22.0		185	4.0	7.00		36	60	49
-140HT	140	150		<0.5	25.0		215	4.5	7.20		39	60	57
FL-4605-80HT	80	85	[F]	<0.5	16.5	[E]	130	3.5	6.55	[E]	24HRC	60HRC	32
-100HT	100	110		<0.5	18.0		165	4.5	6.75		29	60	42
-120HT	120	130		<0.5	20.0		195	6.0	6.95		34	60	49
-140HT	140	155		<0.5	21.5		230	7.0	7.20		39	60	59

[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] Fatigue limit values are estimates derived as 38 % of typical ultimate tensile strength and were not experimentally determined.
[E] Additional data in preparation will appear in subsequent editions of this standard.
[F] Yield and ultimate tensile strength are approximately the same for heat-treated materials.

TABLE X1.10 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		Un-notched Charpy Impact Energy	Trans-verse Rupture Strength	Compres-sive 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 (ap-parent)	Micro (con-verted)		
	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	60HRB		140	6.80
-40	280		400	320	1.0	140	0.27	12	790	320	66	N/A	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	28HRC	60HRC	210	6.60
-100HT		690	760		<0.5	130	0.26	9	1100	760	32	60	260	6.80
-120HT		830	900		<0.5	140	0.26	11	1280	970	36	60	300	7.00
-140HT		970	1030		<0.5	155	0.27	16	1480	1170	30	60	340	7.20
FL-4405-35	240		360	290	1.0	120	0.25	8	690	270	60HRB		140	6.70
-40	280		400	320	1.0	135	0.27	15	860	310	67	N/A	190	6.90
-45	320		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	24HRC	60HRC	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	60HRB		140	6.75
-40	280		400	320	1.0	140	0.27	15	830	310	65	N/A	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	0.24	6	900	630	24HRC	60HRC	200	6.55
-100HT		690	760		<0.5	125	0.25	8	1140	790	29	60	260	6.75
-120HT		830	900		<0.5	140	0.26	11	1340	960	34	60	320	6.95
-140HT		970	1070		<0.5	155	0.27	16	1590	1170	39	60	370	7.20
FLN-4205-40	280		400	320	1.0	115	0.25	8	720	310	64HRB		140	6.60
-45	310		460	360	1.0	130	0.27	11	860	340	70	N/A	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	24HRC	60HRC	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

[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.

TABLE X1.11 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-lb = 1.356 J.

P/M Material Properties																
Minimum Values[A]				Typical Values[B]												
Material Designation Code	Minimum Strength[A,C]		Minimum Elongation (in 1 inch)	Tensile Properties					Transverse Rupture Strength	Unnotched Charpy Impact Strength	Density	Compressive Yield Strength (0.1 %)	Hardness		10^7 Cycle Fatigue Strength
	Yield	Ultimate		Ultimate Strength	Yield Strength (0.2 %)[D]	Elongation (in 1 in.)	Young's Modulus[E]	Poisson's Ratio					Apparent (direct)	Matrix (converted)	
	10^3 psi		%	10^3 psi	10^3 psi	%	10^6 psi		10^3 psi	ft-lb	g/cm^3	10^3 psi	Rockwell		10^3 psi
SS-303N1-25	25		0.0	39	32	0.5	(C)	(C)	86	3.5	6.4	(C)	62HRB	N/A	(C)
SS-303N2-35	35		3.0	55	42	5	(C)	(C)	98	19	6.5	(C)	63HRB	N/A	(C)
SS-303L-12	12		12.0	39	17	17.5	(C)	(C)	82	(C)	6.6	(C)	21HRB	N/A	(C)
SS-304N1-30	30		0.0	43	38	0.5	(C)	(C)	112	4	6.4	(C)	61HRB	N/A	(C)
SS-304N2-33	33		5.0	57	40	10	(C)	(C)	127	25	6.5	(C)	62HRB	N/A	(C)
SS-304L-13	13		12.0	43	18	23	(C)	(C)	(C)	(C)	6.6	(C)	(C)	N/A	(C)
SS-316N1-25	25		0.0	41	34	0.5	(C)	(C)	108	5	6.4	(C)	59HRB	N/A	(C)
SS-316N2-33	33		5.0	60	39	10	(C)	(C)	125	28	6.5	(C)	62HRB	N/A	(C)
SS-316L-15	15		12.0	41	20	18.5	(C)	(C)	80	35	6.6	(C)	20HRB	N/A	(C)
SS-410-90HT		90	0.0	105	(D)	<0.5	(C)	(C)	113	2.5	6.5	(C)	23HRC	55HRC	(C)

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.

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.

SS410 *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. SS—410 is ferromagnetic.

[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.
N/A Not applicable.
[D] Yeild 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 X1.12 Stainless Steel – 300 Series Alloy (SI)

Material Designation Code	P/M Material Properties														
	MINIMUM VALUES[A]			TYPICAL VALUES[B]											
	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		Fatigue Strength 10^7 Cycle	Density
	Yield	Ultimate		Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio				Macro (apparent)	Micro (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	62HRB	N/A	[C]	6.4
SS-303N2-35	240		3.0	380	290	5.0	115	0.25	26	680	320	63HRB	N/A	[C]	6.5
SS-303N2-38	260		6.0	470	310	10.0	140	0.27	47	N/A	320	70HRB	N/A	[C]	6.9
SS-303L-12	80		12.0	270	120	17.5	120	0.25	54	570	140	21HRB	n/A	[C]	6.6
SS-303L-15	100		15.0	330	170	20.0	140	0.27	75	N/A	200	35HRB	N/A	[C]	6.9
SS-304N1-30	210		0.0	300	260	0.5	105	0.25	5	770	260	61HRB	N/A	[C]	6.4
SS-304N2-33	230		5.0	390	280	10.0	115	0.25	34	880	320	62HRB	N/A	[C]	6.5
SS-304N2-38	260		8.0	480	310	13.0	140	0.27	75	N/A	320	68HRB	N/A	[C]	6.9
SS-304L-13	90		15.0	300	120	23.0	120	0.25	61	N/A	150	30HRB	N/A	[C]	6.6
SS-3404L-18	120		18.0	390	180	26.0	140	0.27	108	N/A	190	45HRB	N/A	[C]	6.9
SS-316N1-25	170		0.0	280	230	0.5	105	0.25	7	740	250	59HRB	N/A	[C]	6.4
SS-316N2-33	230		5.0	410	270	10.0	115	0.25	38	860	300	62HRB	N/A	[C]	6.5
SS-316N2-38	260		8.0	480	310	13.0	140	0.27	65	N/A	320	65HRB	N/A	[C]	6.9
SS-316L-15	100		12.0	280	140	18.5	120	0.25	47	550	150	20HRB	N/A	[C]	6.6
SS-316L-22	150		15.0	390	210	21.0	140	0.27	88	N/A	200	45HRB	N/A	[C]	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
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.

[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/A Not applicable.