Designation: B783 – 04

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

This standard is issued under the fixed designation B783; 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]

A839 Specification for Iron-Phosphorus Powder Metallurgy (P/M) Parts for Soft Magnetic Applications

B243 Terminology of Powder Metallurgy

B328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Metal Structural Parts and Oil-Impregnated Bearings[3]

B528 Test Method for Transverse Rupture Strength of Metal Powder Specimens

E8 Test Methods for Tension Testing of Metallic Materials

E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques

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 B243. 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.

[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] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Composition Requirements

Material Designation		Chemical Composition, Weight %													
		Iron	Copper	Carbon	Nickel	Molybdenum	Chromium	Manganese	Silicon	Sulfur	Phosphorus	Nitrogen	Columbium	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.

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 absorption and inert gas fusion methods (Test Methods E1019) 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 E1019). 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 B328.

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 B328.

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

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.

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 A839.

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)

8.1.1 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.

8.3.1 Transverse rupture strength (see Test Method B528) 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 E8) should be used for determination of 0.2 % offset yield strength.

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)

8.3.3 For determining the tensile strength of heat-treated (sinter-hardened or quenched and tempered) 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 (see Test Methods E8) 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.

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)

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 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.

12. Keywords

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

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 longer a requirement of the specification, with the exception of the iron-phosphorus materials as detailed in Tables X1.1 and X1.2.

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 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.

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."

TABLE X1.1 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]								
			Tensile Properties			Elastic Constants			Hardness		
Material Designation Code[A]	Minimum Density	Maximum Coercive Field	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 1 in.)	Young's Modulus	Poisson's Ratio	Unnotched Charpy Impact Energy	Macro (apparent)	Fatigue Limit 90 % Survival	Density
	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 X1.2 Iron-Phosphorus (SI)

P/M Material Properties											
Mandatory Values[A]			TypicalValues[B]								
			Tensile Properties			Elastic Constants			Hardness		
Material Designation Code[A]	Minimum Density	Maximum Coercive Field	Ultimate Strength	Yield Strength (0.2 %)	Elongation (in 25.4 mm)	Young's Modulus	Poisson's Ratio	Unnotched Charpy Impact Energy	Macro (apparent)	Fatigue Limit 90 % Survival	Density
	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.

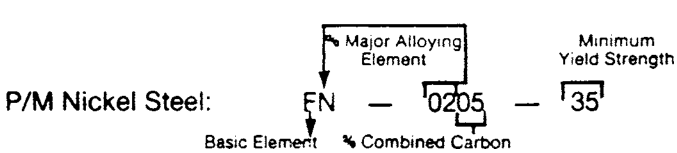

FIG. X1.1 Illustration of P/M Ferrous Material Designation Coding

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 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 X1.3-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

TABLE X1.3 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 X1.4 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.