Designation: B 783 – 99$^{\epsilon 1}$

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.

[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

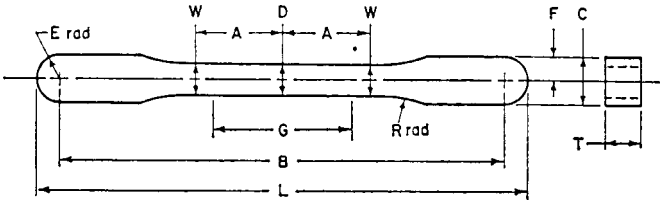
10.1 Parts that fail to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing.

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

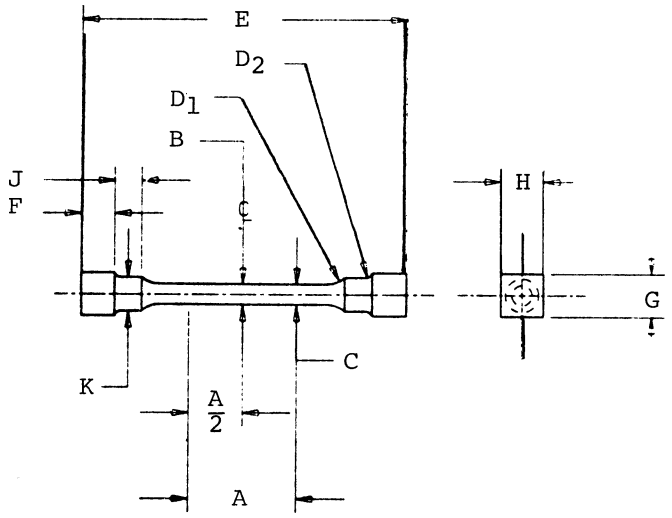
FIG. 1 Standard Flat Unmachined Tension Test Specimen for Powder Metallurgy (P/M) Products

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.