~~Designation:B783–99ε1~~ Designation: B 783 – 04

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

This standard is issued under the fixed designation B 783; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope

~~1.1This 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.~~

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

~~NOTE1—Paragraphs 5.1 and 7.1 will govern material classification by the designation code. The classification system is explained in~~

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:*~~ *ASTM Standards:* [2]

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

B 243 Terminology of Powder Metallurgy

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

~~E8Test Methods for Tension Testing of Metallic Materials~~ Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings

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

E 8 Test Methods for Tension Testing of Metallic Materials

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

2.2 *Other Standard:*

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

3. Terminology

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

~~[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.~~

~~Current edition approved Sept. 10, 1999. Published December 1999. Originally published as B783–88. Last previous edition B783–93.~~

[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.

Current edition approved May 1, 2004. Published June 2004. Originally approved in 1988. Last previous edition approved in 1999 as B 783 – 99ε1.

[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* ~~, Vol 02.05.~~volume information, refer to the standard's Document Summary page on the ASTM website.

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

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

4. Ordering Information

4.1 Materials for parts conforming to this specification shall be ordered by ~~materials~~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

~~5.1Structural~~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.

~~6.2Chemical analysis, if required, shall be made by any method agreed upon by the manufacturer and the purchaser.~~

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

6.3 Various analytical test methods are used to determine the chemical composition (see ASTM standards for the appropriate test methods) of P/M materials. Combustion-infra-red absorption and inert gas fusion methods (Test Methods E 1019) are used for the specific elements of carbon, nitrogen, oxygen and sulfur.

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

7. Physical Properties

7.1 *Density*:

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

~~7.1.2Density shall be determined in accordance with Test Method B328~~

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

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

7.2 *Porosity*:

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

~~7.2.2The 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.~~

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.

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 1Chemical 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~~

TABLE 1 *Continued*

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

TABLE 1 *Continued*

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

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

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

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

8. Mechanical Properties

8.1 The minimum guaranteed tensile strength, as shown in Mechanical Properties

8.1 The guaranteed properties shown in Tables 2-7, is a numerical suffix in the material designation code and is read as 10+

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	Ult Maximum Coercive Field Strength
10³ psi Oe		
g/cm³ Oe		
FY-4500[A]-20V	6.7	2.0
FX-1000-2525	.9	2..
-20W	6.9	2.0
FX-1005-4040	.9	1..
-17W	6.9	1.7
FX-1005-110HT ...	11	0
-20X	7.1	2.0
FX-1008-5050	.1	1..
-17X	7.1	1.7
FX-1008-110HT ...	117.3	2.0
-20Y	7.3	2.0
FX-2000-2525	.3	1..
-17Y	7.3	1.7
FX-2005-4545	.7	1..
FY-8000-17V	6.7	1.7
FX-2005-90HT...	90	
-17W	6.9	1.7
FX-2008-6060	.9	1..
-15W	6.9	1.5
FX-2008-90HT...	907.1	1.7
-17X	7.1	1.7
-15X	7.1	1.5
-15Y	7.3	1.5

[A] 103 psi=6.895 MPa (6.895 N/mm²)

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. The code is adopted from MPIF Standard35. 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.

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

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

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 purchaserproducer and manufacturerthe 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 may also test bars shall be verified using specifically prepared bars, molded formfrom 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 B 528) can be related to the minumumminimum 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. 1Test Methods E 8) should be used for determination of 0.2 % offset yield strength.

8.3.3 For determining the tensile strength of heat-treated (sinter-hardened or quenched and tempered) material, round test bars should be machined from specially molded, as-sintered bars because heat treated, unmachined specimens yield lower values,values. The machined tension test specimens as shown in (see Test Methods E 8Fig. 2 should) shall be heat-treated with the production parts.

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	...
FX-1000-25	25	15 ...
	18	18 ...
	FX-1005-40	18 ...
	21	21 ...
	24	24 ...
FC-0205	30	30 ...
	35	35 ...
	40	40 ...
	45	45 ...
	FX-1005-110HT	... 110
FC-0205	60HT	... 60
FX-1008-50	60HT	... 60
	70HT	... 70
	80HT	... 80
	90HT	... 90
FC-0208	30	30 ...
	40	40 ...
	50	50 ...
	60	60 ...
	FX-1008-110HT	... 110
FC-0208	50HT	...50
FX-2000-25	25	...
	65HT	... 65
	FX-2005-45	45 65
	80HT	...80
	80HT	...
	95HT	... 95
	FX-2005-90HT	... 90
FC-0505	30	30 ...
FX-2008-60	30	30 ...
	40	40 ...
	50	50 ...
FC-0508	40	40 ...
	50	50 ...
	60	60 ...
FC-0808	45	45 ...FC-1000 -2 020 ...
FX-2008-90HT	45	45 ... 9020 ...

[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.

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

10. Rejection and Rehearing

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

11. Certification

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

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

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
~~FN-0200-15~~	~~15~~	...
FC-0200-15	15	...
~~-20~~	~~20~~	...
-18	18	...
~~-25~~	~~25~~	...
-21	21	...
~~FN-0205-20~~	~~20~~	...
-24	24	...
~~-25~~	~~25~~	...
FC-0205-30	30	...
~~-30~~	~~30~~	...
-35	35	...
~~-35~~	~~35~~	...
-40	40	...
~~FN-0205-80HT~~	...	~~80~~
-45	45	...
~~-105HT~~	...	~~105~~
FC-0205-60HT	...	60
~~-130HT~~	...	~~130~~
-70HT	...	70
~~-155HT~~	...	~~155~~
-80HT	...	80
~~-180HT~~	...	~~180~~
-90HT	...	90
~~FN-0208-30~~	~~30~~	...
FC-0208-30	30	...
~~-35~~	~~35~~	...
-40	40	...
~~-45~~	~~45~~	...
-50	50	...
~~-50~~	~~50~~	...
-60	60	...
~~FN-0208-80HT~~	...	~~80~~
FC-0208-50HT	...	50
~~-105HT~~	...	~~105~~
-65HT	...	65
~~-130HT~~	...	~~130~~
-80HT	...	80
~~-155HT~~	...	~~155~~
-95HT	...	95
~~-180HT~~	...	~~180~~
FN-0405-25	25	...
FC-0505-30	30	...
~~-35~~	~~35~~	...
-40	40	...
~~-45~~	~~45~~	...
-50	50	...
~~FN-0405-80HT~~	...	~~80~~
FC-0508-40	40	~~80~~
~~-105HT~~	...105	
-105HT	...	
~~-130HT~~	...	~~130~~
-50	50	~~130~~
~~-155HT~~	...155	
-155HT	...	
~~-180HT~~	...	~~180~~
-60	60	...
~~FN-0408-35~~	~~35~~	...
FC-0808-~~35~~	~~35~~	...
-45	45	...
~~-55~~	~~55~~	...
FC-1000-20	20	...

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

TABLE 6 Minimum Tensile Strength for Low Alloy Steel
Nickel Steel

Material Designation Code	Minimum Strength	
	Yield	Ultimate
	10^3 psi[A]	
~~FL-4205-15~~	~~15~~	~~...~~
FN-0200-15	15	...
-20	20	...
-25	25	...
FN-0205-20	20	...
-25	25	...
-30	30	...
-35	35	...
~~FN-0205-80HT~~		~~80~~
FN-0205-80HT	...	80
~~-100HT~~	~~...~~	~~100~~
-105HT	...	105
~~-120HT~~	~~...~~	~~120~~
-130HT	...	130
~~-140HT~~	~~...~~	~~140~~
-155HT	...	155
-180HT	...	180
~~FL-4605-30~~	~~30~~	~~...~~
FN-0208-30	30	...
-35	35	...
-40	40	...
-45	45	...
-50	50	...
~~FN-0208-80HT~~		~~80~~
FN-0208-80HT	...	80
~~-100HT~~	~~...~~	~~100~~
-105HT	...	105
~~-120HT~~	~~...~~	~~120~~
-130HT	...	130
~~-140HT~~	~~...~~	~~155~~
-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)