



SURFACE VEHICLE STANDARD

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Sintered Powder Metal Parts: Ferrous

RATIONALE

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1. **Scope**—Powder metal (P/M) parts are manufactured by pressing metal powders to the required shape in a precision die and sintering to produce metallurgical bonds between the particles, thus generating the appropriate mechanical properties. The shape and mechanical properties of the part may be subsequently modified by repressing or by conventional methods such as machining and/or heat treating.

While powder metallurgy embraces a number of fields wherein metal powders may be used as raw materials, this standard is concerned primarily with information relating to mechanical components and bearings produced from iron-base materials.

2. **References**—There are no referenced publications specified herein.
3. **Bearings**—Powder metal bearings are classified broadly in two groups: ferrous and nonferrous. While much of the basic information is common to both types, this standard is concerned only with the former. Information relating to copper- and aluminum-base materials is under development.
- 3.1 **Chemical Composition**—The chemical composition shall be determined on an oil-free basis and shall conform to the limits set out in Table 1. The analysis shall be performed in accordance with ASTM procedure, or any other approved method agreed upon by the manufacturer and the purchaser.

Subject to agreement between purchaser and manufacturer metallographic estimates of combined carbon values may be used.

In cases of disagreement in respect of composition, samples shall be submitted to independent umpire analysis.

- 3.2 **Physical and Mechanical Properties**—A most important characteristic of oil impregnated sintered bearings is their property of self-lubrication resulting from the internal oil reservoir created by the interconnected pore structure. The quantity of oil available is thus directly proportional to the pore volume of the bearing. The mechanical strength of bearings of the same composition produced under similar manufacturing conditions is inversely proportional to the pore volume. Although a tensile bar pressed and sintered under the same conditions as the bearing is sometimes used to evaluate materials, the generally accepted test is a radial crush test in which the load required to break the bearing is related to its physical dimensions via a constant, K , specified for each material.

- 3.2.1 **DENSITY**—The density of the bearing, fully impregnated with lubricant (see Appendix B), shall conform to the limits set out in Table 1. If in one bearing the variation of density from any one section to any other is less than 0.3 g/CM³, the density of the bearing as a whole shall fall within the limits prescribed in Table 1. If this point-to-point variation exceeds 0.3 g/CM³, the manufacturer and purchaser shall agree upon a critical section of the part in which the density requirements of the specification must be fulfilled.
- 3.2.2 **OIL CONTENT**—The oil content of the bearing shall not be less than that specified in Table 1. (See Appendix B.)
- 3.2.3 **RADIAL CRUSHING STRENGTH**—Radial crushing strength (see Appendix A) shall not be less than the value calculated as follows:

$$P = \frac{KLT^2}{D - T} \quad (\text{Eq. 1})$$

where:

P = radial crushing load, lb (N)
 D = outside diameter of bearing, in. (mm)
 T = wall thickness of bearing, in. (mm)
 L = length of bearing, in. (mm)
 K = strength constant shown in Table 1

- 3.2.4 **PERMISSIBLE LOADS**—In calculating permissible loads, the operating conditions, housing conditions, and construction should be considered. Permissible bearing loads for various operating conditions are shown in Table 2. These are intended only as a general guide.

Certain conditions will increase the permissible loads, such as additional lubrication, pressure lubrication, hardening of the shaft, loads of short duration.

Certain conditions will tend to reduce the load-carrying capacity of bearings regardless of type or make: continued start-stop operation, oscillating and reciprocating motion, extremely high or low temperatures; excessively close or loose bearing clearances; deflection or misalignment of shaft; dust, grit, corrosive fumes, or poor shaft finish.

3.3 Dimensional Characteristics

- 3.3.1 **TOLERANCES**—Dimensional tolerances allowed shall conform to the limits prescribed in Tables 3 and 4, unless otherwise agreed between supplier and purchaser.

TABLE 1—PROPERTIES OF FERROUS P/M BEARINGS

SAE No.	Density, g/cm ³	Chemical Composition, % Cu	Chemical Composition, % C	Chemical Composition, % Others	Chemical Composition, % Fe	Minimum Oil Content by Volume, %	Strength Constant psi	Strength Constant MPa
850	5.7-6.1	—	0.25 max	2.0 max	Bal	18	25,000	172
851	5.7-6.1	—	0.25-0.60	2.0 max	Bal	18	30,000	207
862	5.8-6.2	7-11	0.30 max	2.0 max	Bal	18	40,000	276
863	5.8-6.2	18-22	0.30 max	2.0 max	Bal	18	40,000	276

TABLE 2—PERMISSIBLE BEARING LOADS

Shaft Velocity ft/min	Shaft Velocity m/min	Permissible Loads SAE 850/851 psi	Permissible Loads SAE 850/851 MPa	Permissible Loads SAE 862/863 psi	Permissible Loads SAE 862/863 MPa
Static (0)	0	7500	52	15,000	103
Slow and intermittent (25)	7.6	3600	25	8,000	55
50-100	15.2-30.4	1800	12	3,000	21
100-150	30.4-45.7	450	3.1	700	4.8
150-200	45.7-61	300	2.1	400	2.8
Over 200	61	225	1.6	300	2.1

For shaft velocities in excess of 200 ft/min (61 m/min), the permissible load may be calculated as follows:

$$P = 50,000/V$$

where:

P = safe load per square inch of projected area, psi

V = shaft velocity, ft/min

$$P = 105/V$$

or:

P = safe load per square metre of projected area, MPa

V = shaft velocity, m/min

TABLE 3—COMMERCIAL DIMENSIONAL TOLERANCES

Note: This table is intended for bearings with a 3:1 maximum length to inside diameter ratio and a 20:1 maximum length to wall thickness ratio. Bearings having greater ratios than these are not covered by the table.

Inside Diameter and Outside Diameter in	Inside Diameter and Outside Diameter mm	Total Diameter Tolerance ⁽¹⁾ Inside Diameter in	Total Diameter Tolerance ⁽¹⁾ Inside Diameter mm	Total Diameter Tolerance ⁽¹⁾ Outside Diameter in	Total Diameter Tolerance ⁽¹⁾ Outside Diameter mm
Up to 0.760	Up to 19.31	0.001	0.025	0.001	0.025
0.761 to 1.510	19.32 to 38.36	0.0015	0.025	0.0015	0.04
1.511 to 2.510	38.37 to 63.76	0.002	0.05	0.002	0.05
2.511 to 3.010	63.77 to 76.46	0.003	0.08	0.002	0.05
3.011 to 4.010	76.47 to 101.86	0.004	0.10	0.004	0.10
4.011 to 5.010	101.87 to 127.26	0.005	0.13	0.005	0.13
5.011 to 6.010	127.27 to 152.65	0.006	0.15	0.006	0.15

1. Total tolerance on the inside diameter and outside diameter is a minus tolerance only.

Length in	Length mm	Total Length Tolernace ⁽¹⁾ in	Total Length Tolerance ⁽¹⁾ mm
Up to 1.495	Up to 37.97	0.010	0.25
1.496 to 1.990	37.98 to 50.54	0.015	0.38
1.991 to 2.990	50.55 to 75.96	0.020	0.51
2.991 to 4.985	75.97 to 126.61	0.030	0.76

1. Total tolerance is split into plus and minus.

Outside Diameter in	Outside Diameter mm	Wall Thickness, max in	Wall Thickness, max mm	Concentricity Tolerance ⁽¹⁾ in	Concentricity Tolerance ⁽¹⁾ mm
Up to 1.510	Up to 38.36	Up to 0.355	9.02	0.003	0.08
1.511 to 2.010	38.37 to 51.06	Up to 0.505	12.83	0.004	0.10
2.011 to 4.010	51.07 to 101.86	Up to 1.010	25.65	0.005	0.13
4.011 to 5.010	101.87 to 127.26	Up to 1.510	38.35	0.006	0.15
5.011 to 6.010	127.27 to 152.65	Up to 2.010	51.05	0.007	0.18

1. Total indicator reading.

TABLE 4—FLANGE AND THRUST BEARINGS DIAMETER AND THICKNESS TOLERANCES⁽¹⁾

Flange Bearings, Flange Diameter Tolerances					
Diameter Range		Standard		Special	
in	mm	in	mm	in	mm
0 to 1-1/2	0 to 38	±0.005	±0.13	±0.0025	±0.06
Over 1-1/2 to 3	39 to 76	±0.010	±0.25	±0.005	±0.13
Over 3 to 6	77 to 152	±0.025	±0.64	±0.010	±0.25

1. Standard and special tolerances are specified for diameters, thickness, and parallelism. Special tolerances should not be specified unless required since they require additional or secondary operations and, therefore, are costlier.