Designation: B 439 – 06

Standard Specification for Iron-Base Powder Metallurgy (PM) Bearings (Oil Impregnated)[1]

This standard is issued under the fixed designation B 439; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers porous metallic sleeve, flange, thrust, and spherical iron-base bearings that are produced from mixed metal powder utilizing powder metallurgy (PM) technology and then impregnated with oil to supply operating lubrication.

1.2 Included are the specifications for the chemical, physical, and mechanical requirements of those ferrous PM materials that have been developed and standardized specifically for use in the manufacture of these self-lubricating bearings.

1.3 This specification is a companion standard to Specification B 438/B 438M that covers the requirements for Bronze-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated).

1.4 Typical applications for iron-base bearings are discussed in Appendix X1.

1.5 Commercial bearing dimensional tolerance data are shown in Appendix X2, while engineering information regarding installation and operating parameters of PM bearings is included in Appendix X3. Additional useful information on self-lubricating bearings can be found in MPIF Standard 35 (Bearings) and the technical literature.[2]

1.6 With the exception of density values for which the g/cm^3 unit is the industry standard, the values stated in inch-pound units are to be regarded as standard. The SI equivalents of inch-pound units, shown in parenthesis, have been converted in accordance with IEEE/ASTM Standard SI 10, may be approximate and are only for information.

1.7 *The following safety hazards caveat pertains only to the test methods described in this specification. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [3]

B 243 Terminology of Powder Metallurgy

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

B 438/B 438M Specification for Bronze Powder Metallurgy (P/M) Bearings (Oil-Impregnated)

B 939 Test Method for Radial Crushing Strength, ***K***, of Powder Metallurgy (P/M) Bearings and Structural Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

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

2.2 *MPIF Standard:*[4]

MPIF Standard 35 Materials Standards for PM Self-Lubricating Bearings

2.3 *IEEE/ASTM Standard:*[3]

SI 10 American National Standard for Use of the International System of Units (SI): The Modernized Metric System

2.4 *ISO Standard:*[5]

ISO 2795 Plain Bearings from Sintered Metal—Dimension and Tolerances

3. Terminology

3.1 *Definitions*—The definitions of the terms used in this specification are found in Terminology B 243. Additional descriptive information is available in the Related Materials section of Volume 02.05 of the *Annual Book of ASTM Standards*.

[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 B09.04 on Bearings.

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[2] *Machine Design Magazine*, Vol 54, No. 14, June 17, 1982, pp. 130–142.

[3] 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.

[4] Available from Metal Powder Industries Federations, 105 College Road East, Princeton, NJ 08540, http://www.info@mpif.org.

[5] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

***A Summary of Changes section appears at the end of this standard.**

4. Classification

4.1 This specification uses the established three-part alphanumeric *PM Material Designation Code* to identify the ferrous materials used for self-lubricating bearings. The complete explanation of this classification system is presented in Annex A1.

4.2 The following standard oil-impregnated iron-base bearing material compositions are contained in this specification:

4.2.1 *Prefix F—Iron Bearing Material*:

4.2.1.1 *F-0000-K15*—Iron with less than 0.3 % combined carbon at 5.6 to 6.0 g/cm^3 wet density.

4.2.2 *Prefix F—Iron-Carbon (Steel) Bearing Material*:

4.2.2.1 *F-0005-K20*—Low carbon steel with 0.3 to 0.6 % combined carbon at 5.6 to 6.0 g/cm^3 wet density.

4.2.3 *Prefix FC—Iron-CopperBearing Materials*:

4.2.3.1 *FC-1000-K20*—Iron with 10 % copper at 5.6 to 6.0 g/cm^3 wet density.

4.2.3.2 *FC-2000-K25*—Iron with 20 % copper at 5.6 to 6.0 g/cm^3 wet density.

4.2.4 *Prefix FCTG—Iron-Bronze-Graphite (Diluted Bronze) Bearing Material*:

4.2.4.1 *FCTG-3604-K22*—90/10 bronze with 60 % iron and 0.75 % graphitic carbon at 6.0 to 6.4 g/cm^3 wet density.

4.2.5 *Prefix FG—Iron-Graphite Bearing Materials*:

4.2.5.1 *FG-0303-K10*—Iron with less than 0.5 % combined carbon and 2.5 % graphitic carbon at 5.6 to 6.0 g/cm^3 wet density.

4.2.5.2 *FG-0308-K16*—Steel with 0.5 to 1.0 % combined carbon and 2 % graphitic carbon at 5.6 to 6.0 g/cm^3 wet density.

5. Ordering Information

5.1 Purchase orders or contracts for iron-base oil-impregnated PM bearings covered by this purchasing specification shall include the following information:

5.1.1 A copy of the bearing print showing dimensions and tolerances (Section 10),

5.1.2 Reference to this ASTM specification, including date of issue,

5.1.3 Identification of bearing material by the *PM Material Designation Code* (Section 4),

5.1.4 Request for certification and test report documents, if required (Section 16),

5.1.5 Type and grade of special lubricating oil, if required (6.2.3), and

5.1.6 Instructions for special packaging, if required (Section 17).

6. Materials and Manufacture

6.1 *Porous Metallic Bearing*:

6.1.1 Sintered iron-base bearings shall be produced by first compacting iron, copper, and graphite mixed powders plus elemental or pre-alloyed copper and tin powders of the desired composition to the proper density and bearing configuration.

6.1.2 The green bearings shall then be sintered in a furnace having a protective atmosphere for a time and temperature cycle that will produce the required sintered ferrous-base PM material.

6.1.3 After sintering, the iron-base bearings are normally sized to achieve the density, dimensional characteristics, concentricity, and surface finish required of the metallic bearing.

6.2 *Oil for Operating Lubrication*:

6.2.1 The interconnected or open porosity in the bearings shall be filled to the required volume with lubricating oil, either by an extended soaking in the hot oil or preferably by a vacuum impregnation operation.

6.2.2 A medium viscosity petroleum oil is the lubricant used for most bearing applications, but extreme operating conditions such as elevated temperatures, intermittent rotation, extremely low speeds, or heavy loads may require a synthetic lubricant or an oil with a different viscosity.

6.2.3 Unless otherwise specified by the purchaser, a high-grade turbine oil with antifoaming additives and containing corrosion and oxidation inhibitors, having a kinematic viscosity of 280 to 500 SSU [(60×10^{-6} to 110×10^{-6} m^2/s), (60 to 110 cSt)] at 100 °F (38 °C) is normally used as the general purpose lubricating oil.

7. Chemical Composition

7.1 *Chemical Composition Specifications*—Each iron-base PM bearing material shall conform to the chemical composition requirements prescribed in Table 1 when determined on a clean test sample obtained from oil-free bearings.

7.2 *Limits on Nonspecified Elements*—By agreement between the purchaser and the supplier, limits may be established and chemical analyses required for elements or compounds not specified in Table 1.

8. Physical Properties

8.1 *Wet Density*—For each bearing material, the wet density of the as-received bearings, supplied impregnated with lubricating oil shall be within the limits prescribed in Table 1.

8.2 *Oil Content*—For each bearing material, the oil content of the as-received bearing shall not be less than the minimum percentage listed in Table 1.

8.3 *Impregnation Efficiency*—A minimum of 90 % of the interconnected porosity in the as-received bearings shall be impregnated with lubricating oil.

9. Mechanical Properties

9.1 *Radial Crushing Strength*—The radial crushing strength of the oil-impregnated bearing material determined on a plain sleeve bearing or a test specimen prepared from a flange or spherical bearing shall meet the minimum and maximum (if required) strength values listed in Table 1.

10. Dimensions, Mass, and Permissible Variations

10.1 This specification is applicable to iron-base PM sleeve and flange bearings having a 3 to 1 maximum length to inside diameter ratio and a 20 to 1 maximum length to wall thickness ratio.

10.2 Standard sleeve, flange, thrust, and spherical PM bearings covered by this specification are illustrated by Figs. 1-4. Most PM bearings are small and weigh less than one-quarter pound (~100 g) but they can be produced in sizes that will accommodate shafts up to approximately 8 in. (200 mm) in diameter.

TABLE 1 Specifications for Iron-Base Materials Used in PM Bearings

Material Designation Code	Chemical Composition Requirements						Physical Requirements		Mechanical Requirements	
	Iron mass %	Combined Carbon[A] mass %	Graphite Carbon mass %	Copper mass %	Tin mass %	All Others mass %	Wet Density g/cm^3	Oil Content vol %	Radical Crushing Strength, (K)	
									10^3 psi	(MPa)
Iron										
F-0000-K15	bal	0.3 max	. . .	1.5 max	. . .	2.0 max	5.6 to 6.0	21 min	15 min	(100 min)
Iron-Carbon (Steel)										
F-0005-K20	bal	0.3to 0.6	. . .	1.5 max	. . .	2.0 max	5.6 to 6.0	21 min	20 min	(140 min)
Iron-Copper										
FC-1000-K20	bal	0.3 max	. . .	9.0 to 11.0	. . .	2.0 max	5.6 to 6.0	22 min	20 min	(140 min)
FC-1000-K25	bal	0.3 max	. . .	18.0 to 22.0	. . .	2.0 max	5.6 to 6.0	22 min	25 min	(170 min)
Iron-Bronze-Graphite (Diluted Bronze)										
FCTG-3604-K22	bal	0.5 max	0.5 to 1.0[B]	34.0 to 38.0	3.5 to 4.5	2.0 max	6.0 to 6.4	17 min	22 to 50	(150 to 340)
Iron-Graphite										
FG-0303-K10	bal	0.5 max	2.0 to 3.0	. . .	. . .	2.0 max	5.6 to 6.0	18 min	10 to 25	(70 to 170)
FG-0308-K16	bal	0.5 to 1.0	1.5 to 2.5	. . .	. . .	2.0 max	5.6 to 6.0	18 min	16 to 45	(110 to 310)

[A] Metallurgically combined carbon expressed as a percentage of the iron in the material composition.
[B] This specification is listed as 0.5 to 1.3 % total carbon in MPIF Standard 35 (Bearings).

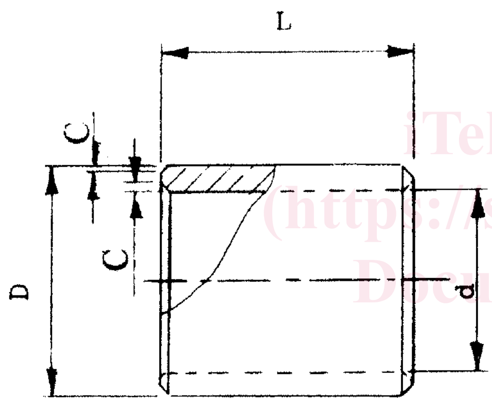

FIG. 1 Standard Sleeve Bearing

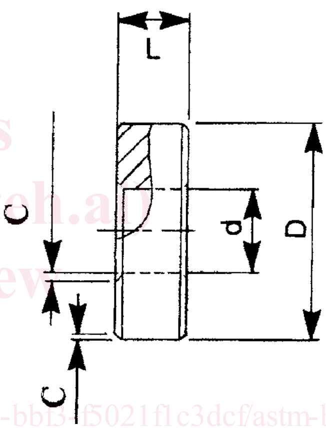

FIG. 3 Standard Thrust Bearing

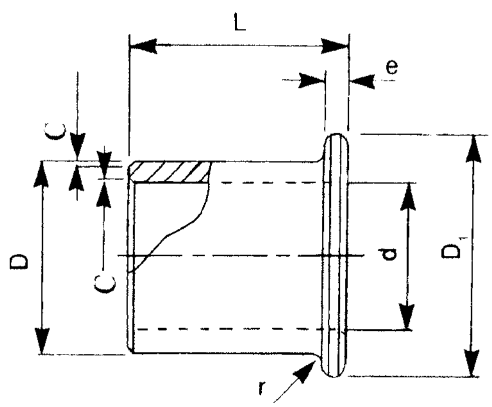

FIG. 2 Standard Flange Bearing

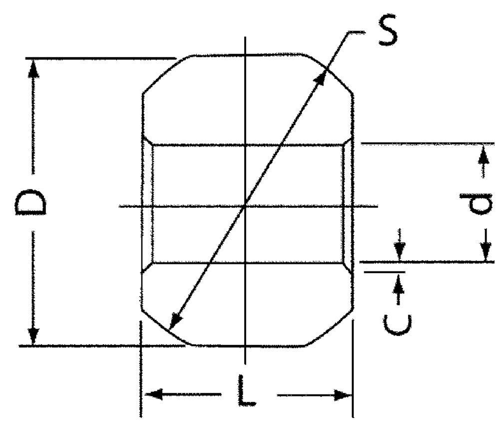

FIG. 4 Standard Spherical Bearing

10.3 Permissible variations in dimensions shall be within the limits specified on the bearing drawing accompanying the order or shall be within the limits specified in the purchase order or contract.

10.4 Recommended commercial tolerances for iron-base PM bearings are referenced throughout the tables in Appendix X2.

10.5 Chamfers of 30 to 45 ° are generally used on PM bearings to break the corners.

11. Workmanship, Finish and Appearance

11.1 The bearings should have a matte surface, and not show oxidation. The surfaces of sized bearings should have a smooth bright finish.

11.2 When cut or fractured, the exposed surface shall exhibit a uniform appearance.

11.3 If metallographic examination is performed to determine degree of sintering, it should be done at 200 to 400× magnification. The iron materials should show a predominantly ferritic or pearlitic phase with uniformly dispersed graphitic carbon (if present). High copper content Iron-Copper materials should show evidence of melted copper as a copper rich skeletal network around a ferrous interior structure. Diluted Bronze material should show a bronze phase with no visible free tin, dispersed throughout an iron matrix. The structure should not show an excessive number of original particle boundaries.

11.4 To verify the presence of oil in the bearing, the as-received bearing may be heated to approximately 300 °F (150 °C) for approximately 5 min. If oil is present, the surfaces will show beads of oil being exuded from the open porosity.

11.5 When bearings are ordered as being "dry-to-the-touch" to allow automated handling by the purchaser, the excess surface oil is normally removed by a centrifugal tumbling operation. It is important that the Oil Content test (13.3.2) be performed after the surface drying treatment to make certain that the required volume of lubricating oil is present.

12. Sampling

12.1 *Lot*—Unless otherwise specified, a lot shall be defined as "a specific quantity of bearings manufactured under traceable, controlled conditions as agreed to between the producer and user" (see Terminology B 243).

12.2 *Sampling Plan*—The number of sample bearings agreed to between the manufacturer and the purchaser to be used for dimensional inspection (13.1), chemical analysis (13.2), physical tests (13.3), and mechanical tests (13.4) shall be taken randomly from locations throughout the lot.

13. Test Methods

13.1 *Dimensional Measurements*:

13.1.1 Using suitable measuring equipment, the inside diameter of the bearings shall be measured to the nearest 0.0001 in. (0.0025 mm). The other bearing dimensions only require instrumentation capable of measuring to the tolerances specified on the bearing drawing.

13.2 *Chemical Analysis*:

13.2.1 *Oil Extraction*—Bearings and test samples must be dry and free of oil before performing chemical tests. The preferred method of oil removal is by use of the Soxhlet Apparatus specified in Test Method B 328. However, upon agreement between purchaser and supplier, a low-temperature furnace treatment [1000 to 1200 °F (540 to 650 °C)] with a flowing nitrogen or other inert gas atmosphere may be used to volatilize any oil or lubricant that may be present.

13.2.2 *Test Sample*—An oil-free test sample of chips shall then be obtained by milling, drilling, filing, or crushing the bearings using clean dry tools without lubrication.

13.2.3 *Metallic Elements*—The chemical analysis for specified metallic elements shall then be performed in accordance with the test methods prescribed in Volume 03.05 of the *Annual Book of ASTM Standards* or by another approved method agreed upon between the manufacturer and the purchaser.

13.2.4 *Carbon Analysis*—Carbon analysis is a set of procedures for determining the total carbon, the graphitic carbon, and the combined carbon in iron-base PM bearings. Total carbon is the sum of graphitic carbon and the total combined carbon.

13.2.4.1 *Total Carbon*—Determine the total carbon in accordance with Test Method E 1019 with the exception that a sample size as small as 0.25 g may be used upon agreement between customer and supplier.

13.2.4.2 *Combined Carbon (Preferred Method)*—The combined carbon content in the iron portion is most easily determined by a metallographic estimate. The etched cross section of the iron matrix is viewed at 200 to 400× magnification and the combined carbon in the iron is estimated from the relative amounts of ferrite and pearlite in the structure. 100 % pearlite is equal to approximately 0.8 % combined carbon in the iron portion. The total combined carbon in the composition is then determined by multiplying the estimated combined carbon in the iron by the percentage of iron in the material.

13.2.4.3 *Graphitic Carbon (Preferred Method)*—Subtract the calculated total combined carbon from the total carbon as determined by Test Method E 1019 (13.2.4.1) to obtain the graphitic carbon in the bearing.

13.2.4.4 *Graphitic Carbon (Alternative Method)*—This wet chemical analytical procedure may be used to determine graphitic carbon content but it is time-consuming and has been found to lack precision. Weigh and transfer a 0.25 g sample of chips to a 400 mL beaker. Add 25 mL of distilled water, then carefully add 25 mL of concentrated nitric acid and gently boil until all the iron is in solution. At this point, add five to ten drops of 48 mass % hydrofluoric acid to ensure complete solubility of all carbides, silicates, and other compounds. Filter the solution through a porous combustion crucible, wash with hot water until free of acid, then rinse with ethyl alcohol. Dry at 212 °F (100 °C) for 1 h. After drying, add approximately 1 g of carbon-free iron chips and 1 g of copper chips (or another approved accelerator) and follow Test Method E 1019 for determining the total carbon.

13.2.4.5 *Combined Carbon (Alternative Method)*—If the graphitic carbon has been determined by wet chemical analysis (13.2.4.4) then the amount of total combined carbon is obtained by subtracting the amount of the graphitic carbon from the total carbon obtained in accordance with Test Method E 1019 (13.2.4.1) Divide this total combined carbon value by the percentage of iron in the composition to determine the amount of combined carbon in the iron portion.

13.3 *Physical Properties*:

13.3.1 *Wet Density*—The wet density in g/cm^3 units, of the as-received oil-impregnated bearings shall be determined following the procedure in Test Method B 328.

13.3.2 *Oil Content*—The oil content shall be determined following the procedure for oil content by volume as received in Test Method B 328.

13.3.3 *Impregnation Efficiency*—The efficiency of the oil-impregnation process in volume percent units shall be calculated as the ratio of the oil content by volume as received to the interconnected porosity using the procedures and formulas in Test Method B 328.

13.4 *Mechanical Properties*:

13.4.1 *Radial Crushing Strength*—Radial crushing strength in psi (MPa) is the mechanical property by which the strength of oil-impregnated PM bearing material is characterized and evaluated. It is determined by breaking plain thin-walled bearings or hollow cylindrical test specimens under diametrical loading, following the procedures described in Test Method B 939, and calculating the radial crushing strength according to the material strength formula contained therein.

13.4.1.1 Plain sleeve bearings and thrust bearings are tested in the as-received oil-impregnated condition. For acceptance, the radial crushing strength, determined on the test bearings, shall not be less than the minimum nor more than the maximum (if applicable) strength specification values listed in Table 1 for the bearing material.

13.4.1.2 Flanged oil-impregnated bearings shall be tested by cutting off the flange and crushing the body as a plain sleeve bearing. For acceptance, the radial crushing strength so determined shall meet the minimum and maximum (if applicable) material strength requirements prescribed in Table 1. The testing procedure and material strength requirements of the flange shall be a matter of agreement between manufacturer and purchaser.

13.4.1.3 To evaluate spherical, or bearings of other configuration, a number of sample bearings from the lot shall first be machined to a right circular cylinder, measured, and then crushed to determine the radial crushing strength of the oil-impregnated bearing material. This value shall not be less than the minimum nor more than the maximum (if applicable) radial crushing strength specified in Table 1 for the material in the sample bearings.

13.4.2 *Bearing Breaking Load*—If agreed to by the manufacturer and the purchaser, an acceptance specification for the minimum (maximum) bearing breaking load, P_{min}, (P_{max}) in lbf (N), may be established for any specific standard oil-impregnated bearing. This simplifies acceptance testing because the decision is now based solely upon reading the output of the testing machine without a need for further calculations. This acceptance procedure can be very useful when evaluating multiple or repeat shipments of the same bearing.

13.4.2.1 The following formula is used to calculate the breaking load, P, for a hollow cylinder or bearing test specimen.

$$P_{min}, (P_{max}) = \frac{K \times L \times t^2}{D - t} \quad (1)$$

where:

P_{min}, (P_{max}) = minimum (maximum) bearing breaking load, lbf (N),
K = minimum (maximum) radial crushing strength, psi (MPa),
L = length of bearing, in. (mm),
t = wall thickness, [$t = (D - d)/2$], in. (mm),
D = outside diameter, in. (mm), and
d = inside diameter, in. (mm).

13.4.2.2 The minimum (maximum) breaking load, P_{min} (P_{max}) required for acceptance of any specific plain sleeve or thrust bearing is calculated using the minimum (maximum) radial crushing strength value specified for that specific plain bearing.

NOTE 1—Using the allowable print, use the minimum (maximum) radial crushing strength value specified for the oil-impregnated bearing material from Table 1 for K, use the actual D, d and L dimensions of the as-received bearing and solve for P_{min}, (P_{max}). This calculated value will be the minimum (maximum) acceptable breaking load for that specific plain bearing. Using the allowable print dimensions that minimize (maximize) the volume of the bearing for the calculations will result in a breaking load specification(s) that will be applicable to any lot of that specific bearing.

13.4.2.3 The minimum (maximum) acceptable breaking load for a specific flanged bearing shall be calculated by first cutting off the flange and measuring the outside diameter, D, the inside diameter, d and the length, L of the body. Then, using the minimum (maximum) radial crushing strength for the oil-impregnated bearing material in Table 1 for K in the breaking load formula and the measured dimensions of the body, a P_{min}, (P_{max}) value may be calculated. This will be the minimum (maximum) bearing breaking load required for the body of that specific flanged bearing. The test procedure and breaking load requirements for the flange shall be a matter of agreement between purchaser and manufacturer.

13.4.2.4 For acceptance testing of whole spherical bearings, a minimum (maximum) bearing breaking load specification, P_{min}, (P_{max}) may be established on a specific whole spherical oil-impregnated bearing. First, the radial crushing strength, K_a, is determined on that specific spherical bearing machined to a plain cylinder as in 13.4.1.3. Second, whole spherical bearings from the same lot are crushed, keeping their axes horizontal, to determine the breaking load, P_a, of the whole bearing. Then, using the correlation formula, the specifications for the breaking load of that whole spherical bearing are calculated as follows:

$$P_{min}, (P_{max}) = \frac{K \times P_a}{K_a} \quad (2)$$

where:

P_{min}, (P_{max}) = specification for the minimum (maximum) bearing breaking load of a specific whole spherical bearing, lbf (N),
K_a = radial crushing strength of the machined test spherical bearings according to 13.4.1.3, psi (MPa),
K = minimum (maximum) radial crushing strength for the bearing material, (from Table 1), psi (MPa), and

P_a = breaking load of whole test spherical bearings, lbf (N).

13.5 *Conformance*:

13.5.1 *Dimensional Measurements*—For purposes of determining conformance with the dimensional specifications, the tolerance limits specified on the bearing print are considered absolute limits as defined in Practice E 29.

13.5.2 *Chemical, Physical, Mechanical Test Results*—For purposes of determining conformance with these specifications, an observed value or calculated value shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of Practice E 29.

13.5.3 *Measurement Uncertainty*—The precision and bias of the test result values shall be considered by the manufacturer and purchaser when determining conformance.

14. Inspection

14.1 The manufacturer shall have the primary responsibility to conduct the necessary measurements and tests to ensure that the bearings meet the requirements of the purchase order and this specification before they are shipped to the customer.

14.2 Upon notification to the purchaser by the manufacturer, all or a portion of the required conformance tests may be contracted to a qualified third party.

14.3 Upon receipt of the shipment, the purchaser may conduct whatever quality control inspections that he feels are necessary to confirm compliance to the purchasing requirements.

15. Rejection and Rehearing

15.1 Rejection based on tests made in accordance with this specification shall be reported in writing to the manufacturer within 30 days of receipt of the shipment. The rejected bearings, however, shall not be returned without written authorization from the supplier.

15.2 In case of dissatisfaction with the test results, either the purchaser or manufacturer may make a claim for rehearing.

16. Certification and Test Report

16.1 The purchaser may require in the purchase order or contract that the manufacturer shall supply a Certificate of Compliance stating that the bearings were produced and tested in accordance with this specification and met all requirements.

16.2 In addition, when required by the purchase order or contract, the manufacturer shall furnish a Test Report that lists the numerical results obtained from the chemical, physical, and mechanical tests performed on the sample bearings.

16.3 Either the Certificate of Compliance or the Test Report may be transmitted by electronic service.

17. Packaging

17.1 Unless specific packaging requirements are included in the purchase order or contract, the finished oil-impregnated PM bearings shall be packaged and shipped in containers of a nonabsorbent material to prevent loss of lubricating oil.

18. Keywords

18.1 bearing breaking load; interconnected porosity; oil content; oil-impregnated bearings; open porosity; PM bearings; porous metallic bearings; PV factor; PV limit; radial crushing strength; self-lubricating bearings; wet density

ANNEXES

(Mandatory Information)

A1. PM MATERIAL DESIGNATION CODE

A1.1 Introduction

A1.1.1 The *PM Material Designation Code* is a three-part alphanumeric array that was developed by the Metal Powder Industries Federation (MPIF) to identify any powder metallurgy material and present fundamental chemical and strength requirement information and is used herein with their permission. It is applicable to all standardized powder metallurgy structural and bearing materials. The array consists of a one to four letter prefix code identifying the base material, a four or five digit chemical composition code giving numeric information about the composition and a suffix code that specifies the minimum strength of the material. The identification system defines a specific standard PM material.

A1.1.2 This system offers a convenient means of designating both the chemical composition and the mechanical strength requirements of any standard PM material. For oil-impregnated bearings, the mechanical strength is listed as the minimum radial crushing strength in 10^3 psi units and the value preceded by the letter "K" to distinguish bearing material from structural material.

A1.1.3 Physical properties are not indicated within the *PM Material Designation Code*. Rather, the material specifications for oil content, interconnected porosity, and wet density are listed in the Physical Requirements table shown for each standardized material.

A1.1.4 Code designations in this specification and revisions thereof apply only to PM materials for which specifications have been formally adopted. In order to avoid confusion, the PM designation coding system is intended for use only with