Designation: F104 – 11

# Standard Classification System for Nonmetallic Gasket Materials[1]

This standard is issued under the fixed designation F104; 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 classification system[2] provides a means for specifying or describing pertinent properties of commercial nonmetallic gasket materials. Materials composed of asbestos, cork, cellulose, and other organic or inorganic materials in combination with various binders or impregnants are included. Materials normally classified as rubber compounds are not included, since they are covered in Classification D2000. Gasket coatings are not covered, since details thereof are intended to be given on engineering drawings or in separate specifications. Facing materials for laminate composite gasket materials (LCGM) are included in Classification System F104. Assembled LCGMs are covered in Classification F868.

1.2 Since all of the properties that contribute to gasket performance are not included, use of the classification system as a basis for selecting materials is limited.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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:*[2]

C561 Test Method for Ash in a Graphite Sample

D1170 Specification for Nonmetallic Gasket Materials for General Automotive and Aeronautical Purposes (Withdrawn 1968)[3]

D2000 Classification System for Rubber Products in Automotive Applications

D5964 Practice for Rubber IRM 901, IRM 902, and IRM 903 Replacement Oils forASTM No. 1, ASTM No. 2, and ASTM No. 3 Oils

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

F36 Test Method for Compressibility and Recovery of Gasket Materials

F37 Test Methods for Sealability of Gasket Materials

F38 Test Methods for Creep Relaxation of a Gasket Material

F146 Test Methods for Fluid Resistance of Gasket Materials

F147 Test Method for Flexibility of Non-Metallic Gasket Materials

F148 Test Method for Binder Durability of Cork Composition Gasket Materials

F152 Test Methods for Tension Testing of Nonmetallic Gasket Materials

F433 Practice for Evaluating Thermal Conductivity of Gasket Materials

F607 Test Method for Adhesion of Gasket Materials to Metal Surfaces

F868 Classification for Laminated Composite Gasket Materials

F1315 Test Method for Density of a Sheet Gasket Material

G21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

## 3. Significance and Use

3.1 This classification system is intended to encourage uniformity in reporting properties; to provide a common language for communications between suppliers and consumers; to guide engineers and designers in the test methods commonly used for commercially available materials; and to be versatile enough to cover new materials and test methods as they are introduced.

3.2 This system is based on the principle that nonmetallic gasket materials can be described in terms of specific physical and mechanical properties. This enables the user, or producer, to characterize a nonmetallic gasket based on properties that are important for the application.

[1] This classification is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.30 on Classification.

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

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## 4. Basis of Classification

4.1 To permit "line call-out" of a material's physical and mechanical properties, this classification system establishes letter and number symbols for various performance levels of each property or characteristic.

4.2 Each "line call out" shall include:
- ASTM F104
- In parentheses, the letter "F" followed by 6 numerals describing the required basic characteristics per 8.1.
- Within the same parentheses, a dash "-" shall follow the basic characteristics, along with any supplemental characteristics per 8.2.

All six (6) numeric fields defining the basic characteristics must be occupied. If a particular characteristic is not required, a "0" must be used as a placeholder to indicate such.

4.3 The six (6) numeric fields used in the basic characteristics define (in order):

*(1)* Principal reinforcement
*(2)* Manufacturing method
*(3)* Compressibility
*(4)* Thickness increase in IRM 903 oil
*(5)* Weight increase in IRM 903 oil
*(6)* Weight increase in water

Example 1:
ASTM F104 (F725400) describes a gasket material with only basic characteristics defined as follows: first numeral – 7 (non-asbestos fiber, tested as type 1); second numeral – 2 (beater process); third numeral – 5 (20 to 30 % compressibility per Test Method F36); forth numeral – 4 (15 to 30 % thickness increase after immersion in IRM 903 Oil per Test Methods F146); fifth numeral – 0 (no Requirement for weight increase in IRM 903 oil per Test Methods F146); sixth numeral – 0 (no requirement for weight increase in water per Test Methods F146).

4.4 Supplemental characteristics may be added to line call out based on the needs of the application. The alpha numerics used to specify various supplemental characteristics are defined in 8.2.

Example 2:
ASTM F104 (F725400-B5E66M4) describes a gasket material with the same basic characteristics defined by Example 1, along with supplemental characteristics defined as follows: B5 (30 % creep relaxation per Test Methods F38); E66 (60 % weight change, and 15 to 35 % thickness change in ASTM Fuel B per Test Methods F146); M4 (no less than 6.895 MPa tensile strength per Test Methods F152).

4.5 The numeral "9" is used when the description of any characteristic (or test related thereto) is specified by some supplement to this classification system, such as notes on engineering drawings. This notation may be used to modify a test characteristic to a value not available in the tables; define gasket binder type; note use and type of a surface release agent; or note use and type of an adhesive system.

Example 3:
Using the same example and adding an L suffix requirement, ASTM F104 (F725400-B5E66M4L169), since the 9 needs to be defined on the engineering drawing, it is recommended to define the "As Specified" requirement immediately after the F104 line call out. In this case, for L169, the 1 defines the primary fiber as Aramid, the 6 indicates the secondary fiber is cellulose both per 8.2, and the 9 is defined immediately after the line call out as shown here:
ASTM F104 (F725400-B5E66M4L169); L169 (ACM Binder)

NOTE 1—While this "cell-type" format provides the means for close characterization and specification of each property and combinations of properties for a broad range of materials, it is subject to possible misapplications, since impossible property combinations can be coded if the user is not familiar with available commercial materials. Appendix X1 indicates properties, characteristics, and test methods that are normally considered applicable to each type of material.

## 5. Thickness Requirements

5.1 Thickness tolerance guidelines for materials identified by this classification system are provided in 8.4. Use of these guidelines as a requirement must be based on an agreement between part/material provider and end user.

5.2 Unless specified by an ASTM method, default test thickness shall be:

| | |
|---|---|
| All materials except Type 2 and Type 5 Class 1 | 0.8 mm (0.030 in.) |
| Type 2 materials | 1.5 to 6.4 mm (0.060 to 0.25 in.) |
| Type 5, Class 1 materials | 0.4 mm (0.015 in.) |

## 6. Sampling

6.1 Specimens shall be selected from finished gaskets or sheets of suitable size, whichever is the more practicable. If sheets are used, they shall, where applicable, be cut squarely with the grain of the stock, and the grain direction shall be noted by an arrow. If finished gaskets are used, the dimensions of sample and any variations from method must be reported.

6.2 Sufficient specimens shall be selected to provide a minimum of three determinations for each test specified. The average of the determinations shall be considered as the result.

## 7. Conditioning

7.1 Prior to all applicable tests, specimens shall be conditioned as follows:

| TYPE | CLASS | CONDITIONING |
|---|---|---|
| 1 | All Except 3 | Oven conditioned at 100°C (212°F) for 1 h. Cool to 21 to 30°C (70 to 85°F) in a desiccator containing anhydrous calcium chloride. |
| 1 | 3 | Oven condition at 100 ± 2°C (212 ± 3.6°F) for 4 h. Cool to 21 to 30°C (70 to 85°F) in a desiccator containing anhydrous calcium chloride. |
| 2 | All | Controlled humidity room or closed chamber at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity for at least 46 h. |
| 0, 3, or 9 | All | Preconditioned at 21 to 30°C (70 to 85°F) for 4 h in a closed chamber containing anhydrous calcium chloride as a desiccant. The air in the chamber shall be circulated by gentle mechanical agitation. Specimens shall then be transferred immediately to a controlled-humidity room or closed chamber with gentle mechanical circulation of the air and conditioned at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity for at least 20 h. If a mechanical means of maintaining 50 to 55 % relative humidity is not available, a tray containing a saturated solution of reagent grade magnesium nitrate, Mg(NO3)•6H2O, shall be placed in the chamber to provide the required relative humidity. |
| 4 | All | No conditioning required. |
| 5, 7, or 8 | All | Oven conditioned at 100°C (212°F) for 1 h. Cool to 21 to 30°C (70 to 85°F) in a desiccator containing anhydrous calcium chloride. |

7.2 In all cases where testing is conducted outside the area of specified humidity, specimens shall be removed from the chamber one at a time just prior to testing.

## 8. Classification Tables

8.1 Table 1 presents the basic 6 numeric fields and the available physical and mechanical characteristic and the definition of each placeholder in that field.

8.2 Table 2 presents the available supplementary physical and mechanical characteristics and the defined requirements.

8.3 Table 3 contains guideline material thickness tolerances. The tolerances in this table may not be applicable to all types of gasket materials. These values should not be used as part tolerances unless previously agreed on between producer and end user.

8.4 *Thickness:*

8.4.1 Measure the specimens with a device actuated by a dead-weight load. The device shall be capable of reading in 0.02-mm (0.001-in.) or smaller units, and readings shall be estimated to the nearest 0.002 mm (0.0001 in.). The presser foot shall be 6.40 ± 0.13 mm (0.252 ± 0.005 in.) in diameter. The anvil shall have a diameter not less than that of the presser foot. The pressure on the sample shall be as specified in Table 4.

8.4.2 Take the reading by lowering the presser foot gently until it is in contact with the specimen. Take a sufficient number of readings, depending on the size of the specimen, to provide a reliable average value.

## 9. Keywords

9.1 classification; description; gasket; line call-out; nonmetallic gasket; physical and mechanical properties; specification; testing

**TABLE 1 Basic Physical and Mechanical Characteristics**

| Basic Six-Digit Number | Basic Characteristic |
|---|---|
| First Numeral | "*Type*" *of material* (the principal fibrous, particulate, or reinforcement material from which the gasket is made) shall conform to the first numeral of the basic six-digit number, as follows:<br>0 = not specified<br>1 = asbestos<br>2 = cork<br>3 = cellulose<br>4 = fluorocarbon polymer<br>5 = flexible graphite<br>7 = nonasbestos fiber, tested as Type 1<br>8 = vermiculite<br>9 = as specified[A] |
| Second Numeral | *Class of material* (method of manufacture or common trade designation) shall conform to the second numeral of the basic six-digit number, as follows:<br>When *first* numeral is "0" or "9," second numeral:<br>0 = not specified<br>9 = as specified[A]<br>When *first* numeral is "1" or "7," second numeral:<br>0 = not specified<br>1 = compressed sheeter process<br>2 = beater process<br>3 = paper and millboard<br>9 = as specified[A]<br>When *first* numeral is "2," second numeral:<br>0 = not specified<br>1 = cork composition (Class 1)<br>2 = cork and elastomeric (Class 2)<br>3 = cork and cellular rubber (Class 3)<br>9 = as specified[A]<br>When *first* numeral is "3," second numeral:<br>0 = not specified<br>1 = untreated fiber—tag, chipboard, vulcanized fiber, etc. (Class 1)<br>2 = protein treated (Class 2)<br>3 = elastomeric treated (Class 3)<br>4 = thermosetting resin treated (Class 4)<br>9 = as specified[A]<br>When *first* numeral is "4," second numeral:<br>0 = not specified<br>1 = sheet PTFE<br>2 = PTFE of expanded structure<br>3 = PTFE filaments, braided, or woven<br>4 = PTFE felts<br>5 = filled PTFE<br>9 = as specified<br>When *first* numeral is "5" or "8," second numeral:<br>0 = not specified<br>1 = homogeneous sheet<br>2 = laminated sheet<br>9 = as specified[A] |
| Third Numeral | *Compressibility characteristics*, determined in accordance with Test Method F36, shall conform to the percent indicated by the third numeral of the basic six-digit number. (Example: 4 = 15 to 25 %)<br>0 = not specified<br>1 = 0 to 10 %<br>2 = 5 to 15 %*<br>3 = 10 to 20 %<br>4 = 15 to 25 %<br>5 = 20 to 30 %<br>6 = 25 to 40 %<br>7 = 30 to 50 %<br>8 = 40 to 60 %<br>9 = as specified[A]<br>* 7 to 17 % for compressed sheeter process |
| Fourth Numeral | *Thickness increase when immersed in IRM 903 Oil:*[B] determined in accordance with Test Method F146, shall conform to the percent indicated by the fourth numeral of the basic six-digit number. (Example: 4 = 15 to 30 %)<br>0 = not specified<br>1 = 0 to 15 %<br>2 = 5 to 20 %<br>3 = 10 to 25 %<br>4 = 15 to 30 %<br>5 = 20 to 40 %<br>6 = 30 to 50 %<br>7 = 40 to 60 %<br>8 = 50 to 70 %<br>9 = as specified[A] |
| Fifth Numeral | *Weight increase when immersed in IRM 903 Oil:*[B] determined in accordance with Test Method F146, shall conform to the percent indicated by the fifth numeral of the basic six-digit number. (Example: 4 = 30 % max)<br>0 = not specified<br>1 = 10 %, max<br>2 = 15 %, max<br>3 = 20 %, max<br>4 = 30 %, max<br>5 = 40 %, max<br>6 = 60 %, max<br>7 = 80 %, max<br>8 = 100 %, max<br>9 = as specified[A] |

**TABLE 1** *Continued*

| Basic Six-Digit Number | Basic Characteristic |
|---|---|
| Sixth Numeral | *Weight increase when immersed in water:* determined in accordance with Test Method F146, shall conform to the percent indicated by the sixth numeral of the basic six-digit number. See left and below. (Example: 4 = 30 %, max)<br>0 = not specified<br>1 = 10 %, max<br>2 = 15 %, max<br>3 = 20 %, max<br>4 = 30 %, max<br>5 = 40 %, max<br>6 = 60 %, max<br>7 = 80 %, max<br>8 = 100 %, max<br>9 = as specified[A] |

[A] On engineering drawings or other supplement to this classification system.
[B] IRM 901 and IRM 903 have replaced ASTM Oils No. 1 and No. 3, respectively. ASTM Oil No. 3 was discontinued due to potential health risks associated with its use. The manufacturer of ASTM Oil No. 1 discontinued it from their product lineup. A new product was developed to meet the same specification. The user should be aware that results may differ using the IRM oils versus the corresponding obsolete ASTM Oils. IRMs 901 and 903 have been approved by Committee D11, per Practice D5964, as a replacement for ASTM Oils No. 1 and 3. These oils are available from R. E. Carroll, Inc. P.O. Box 5806, Trenton, NJ 08638.

**TABLE 2 Supplementary Physical and Mechanical Characteristics**

| Suffix Symbol | Supplementary Characteristics |
|---|---|
| A9 | *Sealability* characteristics shall be determined in accordance with Test Method F37. External load, internal pressure, other details of test, and results shall be as specified on engineering drawing or other supplement to this classification. |
| B1 through B9 | *Creep relaxation* characteristics shall be determined in accordance with Test Method F38. Loss of stress at end of 24 h shall not exceed the amount indicated by the numeral of the B-symbol.<br>B1 = 10 %<br>B2 = 15 %<br>B3 = 20 %<br>B4 = 25 %<br>B5 = 30 %<br>B6 = 40 %<br>B7 = 50 %<br>B8 = 60 %<br>B9 = as specified[A] |
| D00 through D99 | The former ASTM standard F64, Test Method for Corrosive and Adhesive Effects of Gasket Materials on Metal Surfaces, was discontinued in 1980. The newly established test for adhesion has become Test Method F607. |
| E00 through E99 | *Weight and thickness change after immersion in ASTM Fuel B* shall be determined in accordance with Test Method F146. *Weight increase* shall not exceed the standard rating number indicated by the *first* numeral of the two-digit number of the E-symbol. *Thickness increase* shall not exceed the standard rating number indicated by the *second* numeral of the E-symbol.<br>Weight Increase, % (first numeral)<br>E0_ = not specified<br>E1_ = 10<br>E2_ = 15<br>E3_ = 20<br>E4_ = 30<br>E5_ = 40<br>E6_ = 60<br>E7_ = 80<br>E8_ = 100<br>E9_ = as specified[A]<br>Thickness Increase, % (second numeral)<br>E_0 = not specified<br>E_1 = 0–5<br>E_2 = 0–10<br>E_3 = 0–15<br>E_4 = 5–20<br>E_5 = 10–25<br>E_6 = 15–35<br>E_7 = 25–45<br>E_8 = 30–60<br>E_9 = as specified[A] |
| G000 through G999 | Flexible graphite density shall be indicated by the first numeral of the three digit number of the G-symbol as measured by Test Method F1315. Default density tolerance is ±10 %.<br>Ash content shall be indicated by the second numeral of the three digit number of the G-symbol as measured by Test Method C561.<br>Oxidation weight loss shall be indicated by the third numeral of the three digit number of the G-symbol as measured by FSA-G-604-07 Method B (24 h at 593°C).<br>Density (first numeral)<br>G-0 = Not specified<br>G-1 = 0.1 g/cc (6.2 lb/ft$^3$)<br>G-2 = 0.2 g/cc (12.4 lb/ft$^3$)<br>G-3 = 0.7 g/cc (43.7 lb/ft$^3$)<br>G-4 = 1.0 g/cc (62.4 lb/ft$^3$)<br>G-5 = 1.12 g/cc (70.0 lb/ft$^3$)<br>G-6 = 1.4 g/cc (87.4 lb/ft$^3$)<br>G-9 = As specified[A]<br>Ash Content (second numeral)<br>G-0 = Not specified<br>G-1 = <15 %<br>G-2 = <5 %<br>G-3 = <3 %<br>G-4 = <2 %<br>G-5 = <1 %<br>G-6 = <0.5 %<br>G-9 = As specified[A]<br>Oxidation weight loss (third numeral)<br>G-0 = Not specified<br>G-1 = <70 %<br>G-2 = <50 %<br>G-3 = <20 %<br>G-4 = <10 %<br>G-5 = <5 %<br>G-9 = As specified[A] |
| H | *Adhesion* characteristics shall be determined in accordance with Test Method F607. Results shall be as specified on engineering drawing or other supplement to this classification. |
| K1 through K9 | *THERMAL CONDUCTIVITY* characteristics shall be determined in accordance with Practice F433 using a temperature of 100 ± 2°C (212 ± 3.6°F). The *k*-factor obtained in W/(m·K) [Btu·in./h·ft$^2$·°F] shall fall within the ranges indicated by the numeral of a K symbol. Thermal conductivity testing is normally run as a development tool. This shall not be used as a certifiable requirement unless previously agreed on between material producer and end user.<br>K1 = 0 to 0.09 (0 to 0.65)<br>K2 = 0.07 to 0.17 (0.50 to 1.15)<br>K3 = 0.14 to 0.24 (1.00 to 1.65)<br>K4 = 0.22 to 0.31 (1.50 to 2.15)<br>K5 = 0.29 to 0.38 (2.00 to 2.65)<br>K6 = 0.36 to 0.45 (2.50 to 3.15)<br>K7 = 0.43 to 0.53 (3.00 to 3.65)<br>K8 = 0.50 to 0.60 (3.50 to 4.15)<br>K9 = as specified[A] |
| L000 through L999 | *Type 7, Class 1 or Class 2 materials*. *First fiber* constituent indicated by the *first* numeral of the three-digit number of the L-symbol. *Second fiber* constituent indicated by the *second* numeral of the three-digit number of the L-symbol. *Binder* constituent indicated by the *third* numeral of the three-digit number of the L-symbol.<br>First Fiber (first numeral)<br>L0 = not specified<br>L1 = Aramid<br>L2 = Glass<br>L3 = Carbon<br>L4 = Graphite<br>L5 = Mineral/Inorganic<br>L6 = Cellulose<br>L9 = as specified[A]<br>Second Fiber (second numeral)<br>L0 = not specified<br>L1 = Aramid<br>L2 = Glass<br>L3 = Carbon<br>L4 = Graphite<br>L5 = Mineral/Inorganic<br>L6 = Cellulose<br>L7 = none<br>L9 = as specified[A]<br>Binder (third numeral)<br>L0 = not specified<br>L1 = NBR<br>L2 = SBR<br>L3 = CR<br>L4 = EPDM<br>L5 = IR<br>L6 = CSM<br>L7 = HNBR<br>L9 = as specified[A] |

**TABLE 2** *Continued*

| Suffix Symbol | Supplementary Characteristics |
|---|---|
| M1 through M9 | *Tensile strength* characteristics shall be determined in accordance with Test Method F152 and 9.2. Results in MPa (psi) shall be no less than the value indicated by the numeral of the M-symbol.<br>M1 = 0.689 (100)<br>M2 = 1.724 (250)<br>M3 = 3.447 (500)<br>M4 = 6.895 (1000)<br>M5 = 10.342 (1500)<br>M6 = 13.790 (2000)<br>M7 = 20.684 (3000)<br>M8 = 27.579 (4000)<br>M9 = as specified[A] |
| R | *Binder Durability* characteristics shall be determined in accordance with Test Method F148. There shall be no evidence of disintegration at conclusion of test. Test parameters are described per the following suffixes:<br>R1 = Distilled water at reflux for 3 h.<br>R2 = 35 % hydrochloric acid at reflux for 0.5 h.<br>R3 = IRM 901 Oil at 100 ± 2°C (212 ± 3.6°F) for 70 h.<br>R9 = as specified[A] |
| S | *Volume change* characteristics after immersion shall be determined in accordance with Test Method F146. Results shall be as specified on engineering drawing or other supplement to this classification.<br>SF1 = ASTM Reference Fuel A at 21 to 30°C (70 to 85°F) for 22 h.<br>SO1 = IRM 901 Oil at 100 ± 2°C (212 ± 3.6°F) for 70 h.<br>SO3 = IRM 903 Oil at 100 ± 2°C (212 ± 3.6°F) for 70 h.<br>S9 = Fluid as specified[A]<br>The two "- numerals" following the S designation shall indicate the volume change range. The first numeral shall indicate the minimum volume change and the second numeral shall indicate the maximum volume change per the below: |

| First Numeral | Minimum Change | Second Numeral | Maximum Change |
|---|---|---|---|
| 0 | not specified | 0 | not specified |
| 1 | +15 | 1 | 0 |
| 2 | +5 | 2 | +5 |
| 3 | 0 | 3 | +10 |
| 4 | –2 | 4 | +15 |
| 5 | –5 | 5 | +20 |
| 6 | –10 | 6 | +25 |
| 7 | –15 | 7 | +35 |
| 8 | –20 | 8 | +50 |
| 9 | as specified[A] | 9 | as specified[A] |

| | |
|---|---|
| T | *Flexibility* characteristics shall be determined in accordance with Test Method F147. There shall be no evidence of cracks, breaks, or separation at conclusion of test.<br>TA1 = Flexibility after circulating hot air oven aging at 100 ± 2°C (212 ± 3.6°F) for 70 h.<br>TO1 = Flexibility after IRM 901 Oil at 100 ± 2°C (212 ± 3.6°F) for 70 h.<br>The "- numeral" following the T designation shall indicate the flexibility factor as calculated per Test Method F147. |
| W | *Mildew Resistance* shall be determined for visual effects only as described in Sections 9.3 and 9.3.1 of Practice G21. The only fungus shall be Chaetomium globosum, see Section 6.4.1 of Practice G21. The test unit from which specimens were taken shall be considered defective if one or more of the specimens tested has a rating higher than 0. Specimens taken from gaskets and strips shall be 2 in. long and the approximate width of the material undergoing testing. |
| Z | *Other characteristics* shall be as specified on engineering drawing or other supplement to this classification. |

[A] On engineering drawing or other supplements to this classification.

**TABLE 3 Thickness Tolerances**

| Type and Class of Material (First Two Numerals of Basic Six-Digit Number) | Thickness Specified, mm (in.) | Applicable Tolerance, mm (in.) |
|---|---|---|
| 11, 12, 71 and 72 | 0.41 (0.016) and under | +0.13 (+0.005)<br>−0.05 (−0.002) |
| | over 0.41 (0.016) and under 1.57 (0.062) | ±0.13(±0.005) |
| | 1.57 (0.062) and over | ±0.20(±0.008) |
| 13 | up to 3.18 (0.125) | ±0.13 (±0.005) |
| | 3.18 (0.125) to 12.70 (0.500) | ±0.25 (±0.010) |
| 21 | all thicknesses | ±10 %, or ±0.25 (±0.010) whichever is the greater |
| 22 | under 1.57 (0.062) | ±0.25 (±0.010) |
| | 1.57 (0.062) and over | ±0.38 (±0.015) |
| 23 | 1.57 (0.062) and over | ±0.38 (±0.015) |
| 31, 32, and 33 (also 00 and 99) | 0.41 (0.016) and under | ±0.089 (±0.0035) |
| | over 0.41 (0.016) to 1.57 (0.062) | ±0.13 (±0.005) |
| | over 1.57 (0.062) to 2.39 (0.094) | ±0.20 (±0.008) |
| | over 2.39 (0.094) | ±0.41 (±0.016) |
| 51 and 81 | 1.6 (0.062) and under | ±0.051 (±0.002) |
| 52 and 82 | 12.7 (0.5) and under | ±10 % |

**TABLE 4 Thickness Measurement Stresses and Forces**

| Type of Material of First Numeral of Six-Digit Number | Pressure on Sample, kPa (psi) | Total Force on 6.4 mm (0.252 in.) Presser Foot, N (oz) (reference) |
|---|---|---|
| 1 and 7 | 80.3 ± 6.9 (11.5 ± 1.0) | 2.50 (9.0) |
| 2 | 35 ± 6.9 (5.1 ± 1.0) | 1.11 (4.0) |
| 3 | 55 ± 6.9 (8.0 ± 1.0) | 1.75 (6.3) |
| 0 and 9[A] | 55 ± 6.9 (8.0 ± 1.0) | 1.75 (6.3) |
| 5 and 8 | 80.3 ± 6.9 (11.5 ± 1.0) | 2.50 (9.0) |

[A] Unless otherwise specified on engineering drawing or other supplement to this classification.

# APPENDIX

**(Nonmandatory Information)**

## X1. APPLICABLE TEST METHODS

X1.1 Table X1.1 indicates properties, characteristics, and test methods that are normally considered applicable to each type of material. It is not intended to limit the use of numeral-symbols as provided in Classification System F104 where experience indicates that the related properties, characteristics, or test methods, or all, are applicable.

X1.2 Table X1.2 is being provided to offer an explanation of the system of identification of gasket materials previously used in Specifications D1170 which has been superseded by Classification System F104.

X1.3 A cross reference of P-numbers to the recommended Classification System F104 F-identification numbers are provided in X1.3.3. The ranges and limits based on an F-number assignment may not exactly match those from the former P-number assignment of Specifications D1170. When such a difference exists and cannot be defined as desired by the user by use of F-number basic and supplemental characteristics, the numeral “9” for any such characteristic may be substituted. Use of the numeral “9” for any characteristic, must be defined at the end of the line call out.
Example:

ASTM F104 (F334477 M9; M9 = 8MPa )

X1.3.1 The detailed property description tables for the P-numbers have been eliminated from Classification System F104. These property descriptions can be determined for each recommended replacement F-number from Table 1 and Table 2.[4]

X1.3.2 The cross references of asbestos fiber gasket materials (P1xxx) to the recommended F-number, has been eliminated from this appendix. End users wishing to either continue use of asbestos containing materials, or find a suitable non-asbestos material must contact their prospective gasket manufacturers. Based on the total sealing environment and service requirements, these manufacturers can recommend, and specify via an ASTM F104 F-number, an appropriate gasket material for the application. Simply changing the first numeral from a "1" (asbestos) to a "7" (non-asbestos) for a non-asbestos replacement material is not acceptable. Proper performance validation must be done on any material substitution prior to placing into service. This document does not cover such validation procedures, as each application has its own set of performance requirements, of which it is the responsibility of the end user to specify and execute.

X1.3.3 *Cross Reference Tables:*

X1.3.3.1 Table X1.3 provides a cross reference of P-numbers to a recommended F-number replacement call out for cork containing gasket materials. The base F-number and supplemental characteristics provided for each P-number may not exactly match the original requirements from Specifications D1170, but are a close approximation based on the available limits in Classification System F104.

X1.3.3.2 Table X1.4 provides a cross reference of P-numbers to a recommended F-number replacement call out for cellulose fiber based gasket materials. The base F-number and supplemental characteristics provided for each P-number may not exactly match the original requirements from Specifications D1170, but are a close approximation based on the available limits in Classification System F104.

[4] If it is desired to review the exact P-number property description, a copy of the last active version of Specifications D1170 can be obtained from Global Engineering Documents (email: globalcustomerservice@ihs.com).

**TABLE X1.1 Typical Types of Materials**

NOTE 1—"X" indicates that the test conditions shown in first column have been used to characterize the type of material named in column heading." Dash" (—) indicates that the test method is either "not applicable" to the material named or has not been commonly used in characterizing the material.

| Properties, Characteristics, and Test Methods | Type 1 or 7, Asbestos, Non-Asbestos, or Other Inorganic Fibers | | | Type 2, Cork | | | Type 3, Cellulose or Other Organic Fibers | | | Type 5, Flexible Graphite | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Compressed Asbestos | Beater Addition Asbestos | Asbestos Paper and Millboard | Cork Composition | Cork and Elastomeric | Cork and Cellular Rubber | Untreated Fiber | Treated Protein | Treated Elastomeric | Homogeneous Sheet | Laminated Sheet |
| Compressibility: | | | | | | | | | | | |
| 5000-psi load (Test Method F36, Procedure A) | X | X | — | — | — | — | — | — | — | X | X |
| 100-psi load (Test Method F36, Procedure F) | — | — | — | X | — | X | — | — | — | — | — |
| 1000-psi load (Test Method F36, Procedure H) | — | — | X | — | — | — | — | — | — | — | — |
| (Test Method F36, Procedure G) | — | — | — | — | — | — | X | X | X | — | — |
| 400-psi load (Test Method F36, Procedure B) | — | — | — | — | X | — | — | — | — | — | — |
| Tensile strength | X | X | X | X | X | X | X | X | X | X | X |
| Resistance to exposure in IRM 903 Oil:[A] | | | | | | | | | | | |
| Volume change, 70 h at 100°C (212°F) | — | — | — | — | X | X | — | — | — | — | — |
| Weight increase, 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| Thickness change: 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| 5 h at 150°C (302°F) | X | X | — | — | — | — | — | — | — | — | — |
| Resistance to exposure in ASTM Fuel B: | | | | | | | | | | | |
| Weight increase: 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| 5 h at 21 to 29°C (70 to 84°F) | X | X | — | — | — | — | — | — | — | — | — |
| Thickness change: 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| 5 h at 21 to 29°C (70 to 84°F) | X | X | — | — | — | — | — | — | — | — | — |
| Resistance to exposure in IRM 901 Oil:[A] | | | | | | | | | | | |
| Volume change, 70 h at 100°C (212°F) | — | — | — | — | X | X | X | — | — | — | — |
| Resistance to exposure in ASTM Fuel A: | | | | | | | | | | | |
| Volume change, 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | X | X | X | — | — | — | — |
| Resistance to exposure in distilled water: | | | | | | | | | | | |
| Weight increase, 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| Thickness change, 22 h at 21 to 29°C (70 to 84°F) | — | — | — | — | — | — | X | X | X | — | — |
| Sealability | X | X | X | X | X | X | X | X | X | X | X |
| Creep relaxation | X | X | — | — | — | — | — | — | — | X | X |
| Adhesion | X | X | X | X | X | X | X | X | X | X | X |
| Binder Durability | — | — | — | X | — | — | — | — | — | — | — |
| Flexibility | — | — | — | X | X | X | — | — | — | X | X |
| Thermal Conductivity | X | X | X | X | X | X | X | X | X | X | X |
| Mildew Resistance | — | — | — | X | — | — | — | — | — | — | — |

[A] IRM 901 and IRM 903 have replaced ASTM Oils No. 1 and No. 3, respectively. ASTM Oil No. 3 was discontinued due to potential health risks associated with its use. The manufacturer of ASTM Oil No. 1 discontinued it from their product lineup. A new product was developed to meet the same specification. The user should be aware that results may differ using the IRM oils versus the corresponding obsolete ASTM Oils. IRMs 901 and 903 have been approved by Committee D11, per Practice D5964, as a replacement for ASTM Oils No. 1 and 3. These oils are available from R. E. Carroll, Inc. P.O. Box 5806, Trenton, NJ 08638.

**TABLE X1.2 System of Identification**

| Digit | Type 1 | Type 2 | Type 3 |
|---|---|---|---|
| First Numeral (principal fibrous or particulate material) | 1. Asbestos or other inorganic fibers | 2. Cork | 3. Cellulose or other organic fibers |
| Second Numeral (trade designation) | 1. Compressed asbestos sheet | 1. Cork composition | 0. Tag |
| | 2. Asbestos beater sheet | 2. Cork and rubber | 1. Chipboard |
| | 3. Asbestos paper and millboard | 3. Cork and cellular rubber | 2. Vulcanized fiber |
| | | | 3. Cellulose fiber |
| | | | 4. Fiber and filler compositions |
| Third Numeral (binder or treatment other than sizing) | (Same for all three types) | | |
| | 0. None | | |
| | 1. Protein (glue-glycerin or equivalent) | | |
| | 2. Resin | | |
| | 3. Rubber, Type S, Class A (polysulfide or equivalent) | | |
| | 4. Rubber, Type S, Class SB (acrylonitrile or equivalent) | | |
| | 5. Rubber, Type S, Class SC (chloroprene or equivalent) | | |
| | 6. Rubber, Type R (natural, reclaim, styrene, or equivalent) | | |
| Fourth Numeral (compressibility index) | (Same for all three types) | | |
| Test Method F36, Procedure G | 0. 0 to 5 % | | |
| Total load—1000 psi | 1. 6 to 15 % | | |
| *For identification purposes only.* | 2. 16 to 25 % | | |
| *May not agree with compressibility* | 3. 26 to 35 % | | |
| *in tables where other loads are employed* | 4. 36 to 45 % | | |
| | 5. 46 to 55 % | | |
| | 6. 56 to 65 % | | |
| | 7. 66 to 75 % | | |
| | 8. 76 to 85 % | | |
| | 9. 86 to 95 % | | |
| Suffix Letter | Used to distinguish grades of material within one 4-digit category which differ sufficiently to justify separate tabular values. If only one grade of material is listed in the table, the letter “A” is used. | | |

Example: __ Letter indicating a gasket material included in Specification D1170
__ Cellulose or other organic fibers
__ Rope or chemical wood, or both
__ Binder or treatment, rubber, Type S, Class SC
__ Compressibility index is 26 to 35 %
__ Grade

p 3 3 5 3 A

**TABLE X1.3 Number Identification for Type 2 Gasket Materials**

| P-Number | Former “G” Number | Base F-Number | Supplemental Requirements | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tensile Strength | Binder Durability | | | Volume Change | | | Flexibility Factor | | |
| | | | | Distilled Water | 35 % HCL | IRM 901 Oil | ASTM Fuel A | IRM 901 Oil | IRM 903 Oil | Original | Heat Aged | IRM 901 Oil |
| P2116A | 2114 | F213000 | M2 | R1 | | R3 | | | | | | |
| P2117A | 2113 | F214000 | M2 | R1 | | R3 | | | | | | |
| P2117B | 2112 | F215000 | M1 | R1 | | R3 | | | | | | |
| P2118A | 2111 | F217000 | M1 | R1 | | R3 | | | | | | |
| P2126A | 2214 | F213000 | M2 | R1 | R2 | R3 | | | | | | |
| P2127A | 2213 | F214000 | M1 | R1 | R2 | R3 | | | | | | |
| P2127B | 2212 | F215000 | M1 | R1 | R2 | R3 | | | | | | |
| P2128A | 2211 | F217000 | M1 | R1 | R2 | R3 | | | | | | |
| P2236A | 1221–3 | F226000 | M2 | | | | SF1-52 | SO1-52 | SO3-33 | T5 | TA1-16 | TO1-16 |
| P2243A | 1222–2 | F224000 | M2 | | | | SF1-43 | SO1-53 | SO3-44 | T5 | TA1-16 | TO1-16 |
| P2245A | 1222–3 | F226000 | M2 | | | | SF1-43 | SO1-53 | SO3-44 | T5 | TA1-16 | TO1-16 |
| P2245B | | F228000 | M2 | | | | SF1-54 | SO1-74 | SO3-36 | T5 | TA1-16 | TO1-16 |
| P2246A | 1222–4 | F227000 | M2 | | | | SF1-43 | SO1-53 | SO3-44 | T5 | TA1-16 | TO1-16 |
| P2254A | 1223–2 | F224000 | M2 | | | | SF1-34 | SO1-45 | SO3-18 | T5 | TA1-16 | TO1-16 |
| P2255A | 1223–3 | F226000 | M2 | | | | SF1-34 | SO1-45 | SO3-18 | T5 | TA1-16 | TO1-16 |
| P2255B | | F228000 | M1 | | | | SF1-37 | SO1-62 | SO3-18 | T5 | TA1-16 | TO1-16 |
| P2256A | 1223-4 | F227000 | M2 | | | | SF1-34 | SO1-45 | SO3-18 | T5 | TA1-16 | TO1-16 |
| P2265A | 1211-3 | F226000 | M1 | | | | | | | T5 | TA1-16 | |
| P2268A | 1211-5 | F228000 | M1 | | | | | | | T5 | TA1-16 | |
| P2347A | | F237000 | M1 | | | | SF1-62 | SO1-81 | SO3-62 | T5 | TA1-16 | |
| P2357A | | F237000 | M1 | | | | SF1-36 | SO1-63 | SO3-18 | T5 | TA1-16 | |
| P2367A | | F237000 | M1 | | | | | | | T5 | TA1-16 | |

**TABLE X1.4 Number Identification for Type 3 Gasket**

| P-Number | Former “G” Number | Base F-Number | Tensile Strength |
|---|---|---|---|
| P3002A | 3111 | F313000 | M5 |
| P3102A | 3141 | F315000 | M3 |
| P3200A | 3261 & 3262 | F311000 | M9 |
| P3301A | 3151 | F312000 | M7 |
| P3302C | 3122 | F314000 | M5 |
| P3313B | 3212 | F326128 | M6 |
| P3341A | ... | F332128 | M8 |
| P3341D | ... | F332155 | M7 |
| P3342C | ... | F334134 | M7 |
| P3342F | ... | F334477 | M5 |
| P3342G | 3232-3 | F335167 | M5 |
| P3345A | 3232-6 | F338176 | M3 |
| P3353A | ... | F337577 | M5 |
| P3353B | ... | F337576 | M6 |
| P3354A | 3233-5A | F335176 | M3 |
| P3361A | 3234-2 | F332133 | M6 |
| P3362A | 3234-3 | F335166 | M6 |
| P3365A | 3234-6B | F338197 | M3 |
| P3413A | 3221 | F326127 | M5 |
| P3415A | 3222 | F328148 | M4 |
| P3421A | 3223 | F393144 | M5 |
| P3423A | ... | F396143 | M4 |
| P3441A | ... | F332244 | M6 |
| P3442A | ... | F333146 | M7 |
| P3443B | 3242-2 | F336164 | M4 |
| P3443C | ... | F336176 | M4 |
| P3444A | 3242-3 | F337176 | M3 |
| P3464A | 3243-3 | F337497 | M3 |

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