Designation: F104 – 03 (Reapproved 2009)

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. While the facing materials for laminate composite gasket materials (LCGM) are included in Classification System F104, materials normally classified as LCGM are not covered since they are included 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]

D2000 Classification System for Rubber Products in Automotive Applications

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

G21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

3. Significance and Use

3.1 This classification 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 It is based on the principle that nonmetallic gasket materials should be described, insofar as is possible, in terms of specific physical and mechanical characteristics, and that an infinite number of such descriptions can be formulated by use of one or more standard statements based on standard tests. Therefore, users of gasket materials can, by selecting different

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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.

combinations of statements, specify different combinations of properties desired in various parts. Suppliers, likewise, can report properties available in their respective products.

4. Basis of Classification

4.1 To permit "line call-out" of the descriptions mentioned in 3.2, this classification system establishes letter or number symbols or both for various performance levels of each property or characteristic (see Table 1)[3] .

4.2 In specifying or describing gasket materials, each" line call-out" shall include the number of this system (minus date symbol) followed by the letter "F" and six numerals, for example: ASTM F104 (F125400). Since each numeral of the call-out represents a characteristic (as shown in Table 1), six numerals are always required. The numeral "0" is used when the description of any characteristic is not desired. 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.

4.3 To further specify or describe gasket materials, each "line call-out" may include one or more suffix letter-numeral symbols, as listed in Table 2, for example: ASTM F104 (F125400-B2M4). Various levels of definition may be established by increasing or decreasing the number of letter-numeral symbols used in the "line call-out."

4.4 For convenience, gasket materials are referred to by Type according to the principal fibrous or particulate reinforcement or other material from which the gasket is made and by Class according to the manufacturing method, or the common trade designation. Type numbers correspond with the first numeral, and class numbers correspond with the second numeral of the basic six-digit line call-out, as shown in Table 1.

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. Table X1.1 of this classification indicates properties, characteristics, and test methods that are normally considered applicable to each type of material.

5. Physical and Mechanical Requirements

5.1 Gasket materials identified by this classification shall have the characteristics or properties indicated by the first six numerals of the line call-out, within the limits shown in Table 1, and by additional letter-numeral symbols shown in Table 2.

6. Thickness Requirements

6.1 Gasket materials identified by this classification system shall conform to the thickness tolerances specified in Table 3.

7. Sampling

7.1 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.

7.2 For qualification purposes, thickness shall be 0.8 mm (0.03 in.), except for Type 2, where the qualification thickness is to be 1.5 to 6.4 mm (0.06 to 0.25 in.), and Type 5 Class 1, where the qualification thickness is to be 0.4 mm (0.015 in.). When thicknesses other than those shown above are to be tested, the specification limits shall be agreed to in writing between the purchaser and the supplier.

7.3 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.

8. Conditioning

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

8.1.1 When the first numeral of line call-out is "1" (Type 1 materials), specimens shall be conditioned in an oven at 100 ± 2°C (212 ± 3.6°F) for 1 h and allowed to cool to 21 to 30°C (70 to 85°F) in a desiccator containing anhydrous calcium chloride; *except* when second numeral of line call-out is "3" (Class 3 materials), the specimens shall be conditioned in an oven for 4 h at 100 ± 2°C (212 ± 3.6°F).

8.1.2 When the first numeral of line callout is "2" (Type 2 materials), specimens shall be conditioned at least 46 h in a controlled-humidity room or in a closed chamber with gentle mechanical circulation of the air at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity.

NOTE 2—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, $Mg(NO_3)\cdot 6H_2O$, shall be placed in the chamber to provide the required relative humidity.

8.1.3 When the first numeral of line callout is "3" (Type 3 materials), specimens shall be preconditioned for 4 h at 21 to 30°C (70 to 85°F) 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 for at least 20 h at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity.

8.1.4 When the first numeral of a line callout is "4," no conditioning of specimens is necessary.

8.1.5 When the first numeral of a line callout is "5," "7," or "8," test specimens shall be conditioned in accordance with 8.1.1 (Type 1 materials).

8.1.6 When the first numeral of a line callout is "0" or "9," specimens shall be conditioned as in 8.1.3, unless otherwise specified in supplements to this classification.

8.2 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.

9. Test Methods

9.1 *Thickness*:

9.1.1 Measure the specimens with a device actuated by a dead-weight load. The device shall be capable of reading in

[3] IRM 903 is available from R.E. Carrol, Inc. P.O. Box 5806, Trenton, NJ 08638. The user should be aware that results may differ from results using ASTM Oil No. 3. ASTM Oil No. 3 is no longer commercially available due to potential health risks associated with its use. IRM 903 has been approved by Committee D-11 as a replacement for ASTM Oil No. 3.

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: 0 = not specified 1 = asbestos 2 = cork 3 = cellulose 4 = fluorocarbon polymer 5 = flexible graphite 7 = nonasbestos fiber, tested as Type 1 8 = vermiculite 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: When *first* numeral is "0" or "9," second numeral: 0 = not specified 9 = as specified[A] When *first* numeral is "1" or "7," second numeral: 0 = not specified 1 = compressed sheeter process 2 = beater process 3 = paper and millboard 9 = as specified[A] When *first* numeral is "2," second numeral: 0 = not specified 1 = cork composition (Class 1) 2 = cork and elastomeric (Class 2) 3 = cork and cellular rubber (Class 3) 9 = as specified[A] When *first* numeral is "3," second numeral: 0 = not specified 1 = untreated fiber—tag, chipboard, vulcanized fiber, etc. (Class 1) 2 = protein treated (Class 2) 3 = elastomeric treated (Class 3) 4 = thermosetting resin treated (Class 4) 9 = as specified[A] When *first* numeral is "4," second numeral: 0 = not specified 1 = sheet PTFE 2 = PTFE of expanded structure 3 = PTFE filaments, braided, or woven 4 = PTFE felts 5 = filled PTFE 9 = as specified When *first* numeral is "5" or "8," second numeral: 0 = not specified 1 = homogeneous sheet 2 = laminated sheet 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 %) 0 = not specified 1 = 0 to 10 % 2 = 5 to 15 %* 3 = 10 to 20 % 4 = 15 to 25 % 5 = 20 to 30 % 6 = 25 to 40 % 7 = 30 to 50 % 8 = 40 to 60 % 9 = as specified[A] * 7 to 17 % for compressed sheeter process
Fourth Numeral	*Thickness increase when immersed in IRM 903 Oil:*[3] 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 %) 0 = not specified 1 = 0 to 15 % 2 = 5 to 20 % 3 = 10 to 25 % 4 = 15 to 30 % 5 = 20 to 40 % 6 = 30 to 50 % 7 = 40 to 60 % 8 = 50 to 70 % 9 = as specified[A]
Fifth Numeral	*Weight increase when immersed in IRM 903 Oil:*[3] 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) 0 = not specified 1 = 10 %, max 2 = 15 %, max 3 = 20 %, max 4 = 30 %, max 5 = 40 %, max 6 = 60 %, max 7 = 80 %, max 8 = 100 %, max 9 = as specified[A]
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) 0 = not specified 1 = 10 %, max 2 = 15 %, max 3 = 20 %, max 4 = 30 %, max 5 = 40 %, max 6 = 60 %, max 7 = 80 %, max 8 = 100 %, max 9 = as specified[A]

[A] On engineering drawings or other supplement to this classification system.

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. B1 = 10 % B2 = 15 % B3 = 20 % B4 = 25 % B5 = 30 % B6 = 40 % B7 = 50 % B8 = 60 % 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. Weight Increase, % (first numeral) E0_ = not specified E1_ = 10 E2_ = 15 E3_ = 20 E4_ = 30 E5_ = 40 E6_ = 60 E7_ = 80 E8_ = 100 E9_ = as specified[A] Thickness Increase, % (second numeral) E_0 = not specified E_1 = 0–5 E_2 = 0–10 E_3 = 0–15 E_4 = 5–20 E_5 = 10–25 E_6 = 15–35 E_7 = 25–45 E_8 = 30–60 E_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. K1 = 0 to 0.09 (0 to 0.65) K2 = 0.07 to 0.17 (0.50 to 1.15) K3 = 0.14 to 0.24 (1.00 to 1.65) K4 = 0.22 to 0.31 (1.50 to 2.15) K5 = 0.29 to 0.38 (2.00 to 2.65) K6 = 0.36 to 0.45 (2.50 to 3.15) K7 = 0.43 to 0.53 (3.00 to 3.65) K8 = 0.50 to 0.60 (3.50 to 4.15) 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. First Fiber (first numeral) L0 = not specified L1 = Aramid L2 = Glass L3 = Carbon L4 = Graphite L5 = Mineral/ Inorganic L6 = Cellulose L9 = as specified[A] Second Fiber (second numeral) L0 = not specified L1 = Aramid L2 = Glass L3 = Carbon L4 = Graphite L5 = Mineral/ Inorganic L6 = Cellulose L7 = none L9 = as specified[A] Binder (third numeral) L0 = not specified L1 = NBR L2 = SBR L3 = CR L4 = EPDM L5 = IR L6 = CSM L9 = as specified[A]
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. M1 = 0.689 (100) M2 = 1.724 (250) M3 = 3.447 (500) M4 = 6.895 (1000) M5 = 10.342 (1500) M6 = 13.790 (2000) M7 = 20.684 (3000) M8 = 27.579 (4000) 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.
S9	*Volume change* characteristics, when immersed in ASTM No. 1 Oil, IRM 903 Oil,[3] and ASTM Reference Fuel A, shall be determined in accordance with Test Method F146. Results shall be as specified on engineering drawing or other supplement to this classification.
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.
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 supplement 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,[A] mm (in.)
11, 12, 71 and 72	0.41 (0.016) and under	+0.13 (+0.005) −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)[B]	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 %

[A] Tolerances listed are permissible variations applicable to a given lot of sheets or gaskets. Where other thickness tolerances are necessary due to the gasket application, tolerances applicable to individual sheet or gasket may be agreed to in writing between the purchaser and the supplier.
[B] Unless otherwise specified on engineering drawing or other supplement to this classification.

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.

9.1.2 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.

9.2 *Other Types of Materials* (as indicated by 0 or 9 first numeral of basic six-digit number)—Use the same apparatus and general procedure outlined for Type 3 materials, unless otherwise specified in the engineering drawing or other supplement to this classification.

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 Pressor 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.

10. Keywords

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

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 Tables X1.3-X1.5 are also retained in this Appendix to provide a reference for converting formerly used P-identification numbers into the present Classification System F104. These conversions are shown in Tables X1.6-X1.8.

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, 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 ASTM No. 3 Oil:[3]											
Volume change, 70 h at 212°F	—	—	—	—	X	X	—	—	—	—	—
Weight increase, 22 h at 70 to 85°F	—	—	—	—	—	—	X	X	X	—	—
Thickness increase: 22 h at 70 to 85°F	—	—	—	—	—	—	X	X	X	—	—
5 h at 300°F	X	X	—	—	—	—	—	—	—	—	—
Resistance to exposure in ASTM Fuel B:											
Weight increase: 22 h at 70 to 85°F	—	—	—	—	—	—	X	X	X	—	—
5 h at 70 to 85°F	X	X	—	—	—	—	—	—	—	—	—
Thickness change: 22 h at 70 to 85°F	—	—	—	—	—	—	X	X	X	—	—
5 h at 70 to 85°F	X	X	—	—	—	—	—	—	—	—	—
Resistance to exposure in ASTM No. 1 Oil:											
Volume change, 70 h at 212°F	—	—	—	—	X	X	X	—	—	—	—
Resistance to exposure in ASTM Fuel A:											
Volume change, 22 h at 70 to 85°F	—	—	—	—	X	X	X	—	—	—	—
Resistance to exposure in distilled water:											
Weight increase, 22 h at 70 to 85°F	—	—	—	—	—	—	X	X	X	—	—
Thickness change, 22 h at 70 to 85°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	—	—	—	—	—	—	—

X1.3.1 The ASTM F104 F-identification numbers shown in Tables X1.6-X1.8 have basic characteristic numerals from Table 1 and Table 2 that may not have the same ranges and limits as the corresponding P-idenfication numbers in Tables X1.3-X1.5. When such a difference exists and the P-identification number range or limit is desired the as specified numeral "9" may be substituted for the differing F104 basic characteristic numeral and the Tables X1.3-X1.5 range or limit specified.