

- b) the temperature limits are exceeded; or
- c) 7.5 h has elapsed, and there are no trims that result in the luminaire operating at a higher temperature.

16.4.3.7 If the thermal protector does not open within 3 h, and the temperatures on the luminaire surfaces in contact with thermal insulation and the points of support are less than 90 °C, the test shall be repeated with the trim that resulted in the next higher recessed housing temperature or point-of support temperature, or both, during the normal temperature test. Each iteration shall start with the luminaire at room ambient temperature.

16.4.3.8 If the thermal protector does not open in 3 h and the temperatures on the luminaire surfaces in contact with thermal insulation and the points of support are more than 90 °C, but less than 20 °C above the temperatures measured on these same points during the normal temperature test, the test procedure in Clause [16.4.3.9](#) shall be performed.

16.4.3.9 Perform the following test procedure on a luminaire that complies with Clause [16.4.3.8](#) after the luminaire has reached thermal stabilization:

- a) defeat the thermal protector;
- b) increase the supply voltage to 5 V above that required to make the lamp operate at rated wattage;
- c) operate the luminaire and measure the temperature of points of the luminaire in contact with thermal insulation and points of support after 15 min;
- d) if the temperatures measured are less than 20 °C above the temperature measured at that point during the normal temperature test, return to the point in the procedure described in Item (b) and raise the supply voltage another 5 V; and
- e) when any of the temperatures measured in Item (c) exceed the temperature measured at that point during the normal temperature test by 20 °C:
  - 1) record the supply voltage;
  - 2) de-energize the luminaire and let it cool to room ambient temperature;
  - 3) reconnect the thermal protector;
  - 4) connect the luminaire to a supply adjusted to the voltage recorded in Item (1) and let it operate; and
  - 5) apply Clauses [16.4.3.6](#) and [16.4.3.10](#).

16.4.3.10 Test results shall be acceptable if the thermal protector:

- a) operates within 3 h and the temperature of any part of the luminaire in contact with thermal insulation or the test box does not exceed 160 °C; or
- b) does not operate within 3 h, the test is continued for 7.5 h, and the temperature of any part of the luminaire in contact with thermal insulation or the test box does not exceed 90 °C.

## **16.5 Abnormal overlamping operation test for incandescent luminaires with polymeric housings or enclosures**

16.5.1 A luminaire shall be operated as specified in the normal temperature test, with the largest possible wattage lamp the luminaire accommodates, for 7.5 h.

16.5.2 There shall be no ignition of the polymeric material or exposure of live parts. Shrinkage, warpage, expansion, or cracking shall be acceptable.

## **17 Mechanical tests**

### **17.1 Barrier strength**

17.1.1 A sample luminaire with the barrier mounted as intended shall be tested.

17.1.2 A force of 44.5 N (10 lb) over an area of 6.45 cm<sup>2</sup> (1 in<sup>2</sup>) shall be applied to the barrier for 1 min.

17.1.3 The application of the force shall not result in

- a) permanent distortion of a metal barrier;
- b) temporary or permanent reduction of electrical spacings; or
- c) breaking or cracking of a nonmetallic barrier.

### **17.2 Metal thickness equivalency**

#### **17.2.1 General**

17.2.1.1 A luminaire having reduced metal thickness shall comply with the compression and impact tests described in Clauses [17.2.2](#) and [17.2.3](#). Pendant-mounted luminaires having reduced metal thickness shall additionally comply with the flexing test described in Clause [17.2.4](#) and the torque and cantilever tests in Clauses [17.2.4](#) and [17.2.5](#).

#### **17.2.2 Compression**

17.2.2.1 The luminaire shall be tested as follows:

- a) the luminaire shall be placed on a flat horizontal surface; and
- b) a 111 N (25 lb) force shall be applied, using a rod with a 25.4 mm (1 in) diameter face, to the center of the surface being tested for 1 min.

17.2.2.2 Test results shall be acceptable if:

- a) the electrical spacings comply with Clause [6.12](#); and
- b) the accessibility of uninsulated live parts complies with Clause [6.14.2](#).

#### **17.2.3 Impact**

17.2.3.1 The sample luminaires shall be held in place and subjected to a single 7 J (5 ft·lb) impact, using the impact test apparatus described in Clause [19.21](#), falling through a vertical height of 1.29 m (4.24 ft), on surfaces being tested.

17.2.3.2 The number of samples and the sequence of the procedure shall be in accordance with [Figure 17.2.3.1](#).

**Figure 17.2.3.1**  
**Procedure for impact test**

(See Clause [17.2.3.2](#) and [17.41.2](#).)

Series Num- ber	Sample Number								
	1	2	3	1	2	3	1	2	3
1	↓ A	N	N	↓ A	N	N	↓ A	N	N
2	↓ A	N	N	↓ A	N	N	↓ U	↓ A	N
3	↓ A	N	N	↓ U	↓ A	N	↓ A	N	↓ U

#### NOTES

- (1) Arrows indicate sequence of test procedure.
- (2) A indicates acceptable results from drop.
- (3) U indicates unacceptable results from drop.
- (4) N indicates that no test is necessary.

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17.2.3.3 Test results shall be acceptable if the enclosure is capable of complying with all the applicable requirements of this Standard.

### 17.2.4 Flexing

17.2.4.1 The luminaire shall be supported directly below the pendant support connection points on maximum 25 mm (1 in) wide wooden blocks of sufficient length.

17.2.4.2 A 89 N (20 lb) force shall be applied to a 39 cm<sup>2</sup> (6 in<sup>2</sup>) piece of 19 mm (0.75 in) thick plywood centered on the top of the luminaire midway between the two supports closest to the end.

17.2.4.3 The maximum deflection under load shall be 6.4 mm (0.25 in).

### 17.2.5 Torque and cantilever

#### 17.2.5.1 General

17.2.5.1.1 During the torque and cantilever tests, a comparison shall be made between a control sample luminaire having the minimum metal thickness specified in [Table 5.5.1](#) and a test sample luminaire having reduced metal thickness.

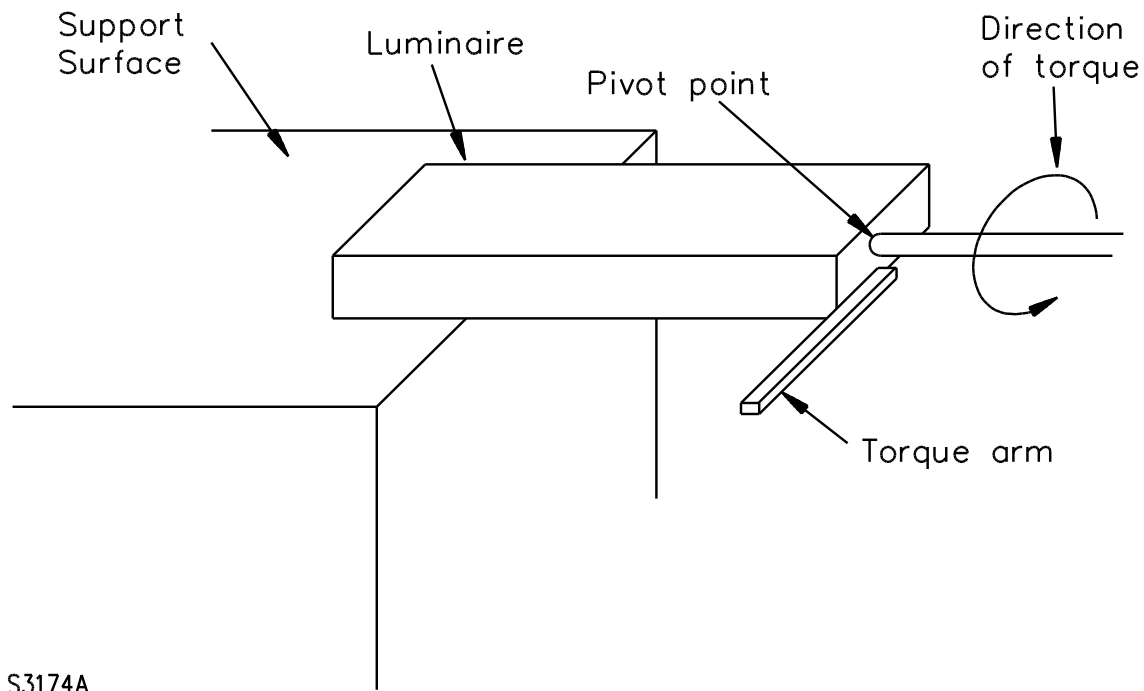
### 17.2.5.2 Torque

17.2.5.2.1 The control and test sample luminaires shall be secured to a solid horizontal surface so that the sample overlaps the surface by a length equal to 10 percent of the sample's overall length. The opposite end of each luminaire shall be supported at the same height as the fixed end by a pivot arm that is attached to the luminaire but allows free rotation of the luminaire around its major axis. A 610 mm (24 in) long torque arm shall be connected to the pivot end of each luminaire at a right angle to its major axis as shown in [Figure 17.2.5.2.1](#).

**Figure 17.2.5.2.1**

**Torque test**

(See Clause [17.2.5.2.1](#).)



17.2.5.2.2 A 4.4 N (1 lb) force shall be applied to one end of the arm in a direction that results in luminaire rotation deflection around the major axis.

17.2.5.2.3 During or after the test, the deflection of the test sample luminaire shall be equal to or less than the deflection of the control sample luminaire.

### 17.2.5.3 Cantilever

17.2.5.3.1 The control and test sample luminaires shall be secured at one end to a solid horizontal surface. The opposite end of each luminaire shall be suspended by the support provided with the luminaire.

17.2.5.3.2 A 11.3 kg (25 lb) weight shall be applied to the suspended end of each luminaire. The weight shall be applied for 1 min.

17.2.5.3.3 During or after the test, the deflection of the test sample luminaire shall be equal to or less than the deflection of the control sample luminaire.

### 17.3 Five-inch flame

17.3.1 Three samples of complete luminaires or enclosure specimens shall be subjected to this test, using the test apparatus of Clause [19.24](#).

17.3.1 (MEX) In Mexico, Clause [17.3](#) does not apply.

17.3.2 The conditioning described in Clause [17.3.3](#) shall be conducted only if:

- a) the enclosure material exhibits a reduction in flame-resistance properties as a result of long-term thermal aging; or
- b) the enclosure material thickness is less than the minimum thickness subjected to the long-term thermal aging.

17.3.3 After conditioning for 40 h at  $23 \pm 2$  °C and  $50 \pm 5$  percent relative humidity, the test samples shall be placed in a full-draft air-circulating oven for 7 d at a temperature at least 10 °C above the temperatures measured during the normal temperature test and, in no case, less than 70 °C.

17.3.4 The sample shall be positioned to simulate intended usage, with a layer of surgical cotton located 300 mm (12 in) below the point of test flame application.

17.3.5 The burner shall be placed in a location remote from the sample, in a vertical position, and ignited. The burner shall be adjusted to provide a  $125 \pm 10$  mm (5 in) overall height flame with a  $40 \pm 2$  mm (1.5 in) high inner blue cone.

17.3.6 The flame shall be applied at an angle of approximately 20 degrees from the vertical to 3 different locations on each of the 3 samples, in the following areas, as appropriate:

- a) any interior portion of the enclosure judged as likely to be ignited (by proximity to live arcing parts, coils, and conductors);
- b) the outside enclosure of encapsulated portions; and
- c) the outside enclosure, if the flame cannot be applied to the interior.

17.3.7 The flame shall be applied for 5 s and removed for 5 s. This cycle shall be repeated 5 times at each location.

17.3.8 Test results shall be acceptable when the following conditions are met:

- a) the material does not continue to burn more than 1 min after the fifth flame application at any of the locations;
- b) there are no flaming drops or glowing particles that ignite the surgical cotton below the sample; and
- c) no visible flame shall be observed on the surface of the enclosure opposite to the surface on which the test flame is applied during the test. In addition, unless otherwise specified in the relevant end-product standard, no opening greater than 3 mm appears after the test has been performed and the sample has cooled for 30 s.

17.3.9 If any one of the 3 samples does not comply, 3 new samples shall comply when the test is repeated in a manner identical to that used for the unsuccessful sample, in order for the test results to be acceptable.

#### **17.4 Mold stress relief**

17.4.1 A sample of the complete thermoplastic enclosure shall be placed in a circulating air oven and maintained at a temperature 10 °C higher than the maximum temperature measured on the surface of the enclosure during the normal temperature test but in no case less than 70 °C, for a period of 7 h.

17.4.2 After the sample has cooled to room temperature, the sample shall comply with the applicable requirements of this Standard.

#### **17.5 Wet locations**

##### **17.5.1 General**

17.5.1.1 A luminaire with an opening for supply connections shall be fitted with the intended supply connection means.

17.5.1.2 A luminaire provided with a receptacle that has an automatic closure cover shall withstand the rain test of Clause [17.5.2](#) and the sprinkler test of Clause [17.5.3](#), with the cover closed.

17.5.1.3 A luminaire provided with a receptacle that does not have an automatic closure shall withstand the rain test of Clause [17.5.2](#) and the sprinkler test of Clause [17.5.3](#) with the cover open, closed, and with and without an attachment plug in place.

##### **17.5.2 Rain**

17.5.2.1 A luminaire that is subjected to the rain test shall be conditioned by performing the normal temperature test of Clause [15](#) or by being operated for at least 30 min.

17.5.2.2 After the conditioning, rings, frames, lamps, and other replaceable parts serving to compress gaskets and bushings shall be removed and then reinstalled.

17.5.2.3 The rain test apparatus shall be in accordance with Clause [19.17](#).

17.5.2.4 The luminaire shall be installed in accordance with the manufacturer's instructions. The mounting shall simulate the intended mounting method, and only the surfaces exposed to the elements shall be subjected to the rain test.

17.5.2.5 The luminaire shall be positioned in the focal area of the spray heads of the rain test apparatus so that the greatest quantity of water is likely to enter the enclosure of the luminaire.

17.5.2.6 The test shall be conducted in the sequence shown in [Table 17.5.2.1](#).

**Table 17.5.2.1**  
**Rain test operating sequence**

(See Clause [17.5.2.6](#).)

Test duration, h	Test period, h	Lamp	Water
0 – 1.0	1.0	On	Off
1.0 – 1.5	0.5	Off	On
1.5 – 3.5	2.0	On	On
3.5 – 4.0	0.5	Off	On

17.5.2.7 Immediately after the rain test, the luminaire shall:

- a) withstand the dielectric voltage-withstand test of Clause [18.1](#);
- b) not have permitted water to enter and accumulate in quantities sufficient to interfere with the operation of the luminaire or to create a hazard; and
- c) not have permitted water to contact electrical parts, except lamps or components suitable for the condition. Drops of water are permitted to be present on the insulation of non-braided thermoplastic insulated wire. The insulation on non-braided thermoplastic insulated wire shall not be in a pool of water unless the insulation is identified as suitable for immersion.

17.5.2.7 (MEX) In Mexico, immediately after the rain test, the luminaire shall withstand the insulation resistance test of Clause [18.5](#) (MEX).

### 17.5.3 Sprinkler

17.5.3.1 A luminaire that is subject to the sprinkler test shall be conditioned by performing the normal temperature test of Clause [15](#) or by being operated for at least 30 min.

17.5.3.2 After the conditioning, rings, frames, lamps, and other replaceable parts of the luminaire serving to compress gaskets and bushings shall be removed and then reinstalled.

17.5.3.3 The sprinkler test apparatus shall be in accordance with Clause [19.18](#).

17.5.3.4 The luminaire shall be installed in accordance with the manufacturer's instructions. The mounting shall simulate the intended mounting method, and only the surfaces exposed to the elements shall be subjected to the sprinkler test.

17.5.3.5 A ground-mounted surface luminaire shall be turned about its vertical axis to four positions, each 90 degrees from the others. It shall remain in each position for 30 min during the 2 h portion of the test, with the adjustable parts arranged for maximum vulnerability to the water spray.

17.5.3.6 A ceiling-mounted or wall-mounted luminaire shall be installed with the vertical axis of the luminaire 910 mm (36 in) away from the vertical plane of the spray head and positioned with the dimensional center of the luminaire on a line projected from the centerline of the spray head.

17.5.3.7 The test shall be conducted in the sequence shown in [Table 17.5.3.1](#).

**Table 17.5.3.1**  
**Sprinkler test operating sequence**

(See Clause [17.5.3.7.](#))

Test duration, h	Test period, h	Lamp	Water
0 – 1.0	1.0	On	Off
1.0 – 1.5	0.5	Off	On
1.5 – 3.5	2.0	On	On
3.5 – 4.0	0.5	Off	On

17.5.3.8 Immediately after the sprinkler test, the luminaire shall:

- a) withstand the dielectric voltage-withstand test of Clause [18.1](#);
- b) not have permitted water to enter and accumulate in quantities sufficient to interfere with the operation of the luminaire or to create a hazard; and
- c) not have permitted water to contact electrical parts, except lamps or components suitable for the condition. Drops of water are permitted to be present on the insulation of non-braided thermoplastic insulated wire. The insulation on non-braided thermoplastic insulated wire shall not be in a pool of water unless the insulation is identified as suitable for immersion.

#### 17.5.4 Immersion

17.5.4.1 A luminaire shall be subjected to the immersion test in accordance with [Table 17.5.4.1](#), with or without an auxiliary well form, and mounted face-up, with the screws that attach the face torqued to the manufacturer's recommended values.

**Table 17.5.4.1**  
**Immersion test operating sequence**

(See Clause [17.5.4.1.](#))

Test duration, h	Test period, h	Lamp	Location
0 – 3.5	3.5	On	Dry
3.5 – 7.5	4.0	Off	Submerged
7.5 – 24.0	16.5	Off	Dry
24.0 – 27.5	3.5	On	Dry
27.5 – 31.5	4.0	Off	Submerged
31.5 – 48.0	16.5	Off	Dry
48.0 – 51.5	3.5	On	Dry
51.5 – 55.5	4.0	Off	Submerged

17.5.4.2 The luminaire shall be conditioned by being operated in a dry location at room temperature for 3.5 h.

17.5.4.3 The luminaire shall be de-energized and immediately submerged under at least 300 mm (12 in) of water. The temperature of the water before submersion shall be 5 °C or lower. The luminaire shall remain under water for at least 4 h and then be removed from the water.



17.5.4.4 The procedure of Clauses [17.5.4.2](#) and [17.5.4.3](#) shall be conducted three times. Before the second sequence and the third sequence, the luminaire shall be conditioned by placing it in a dry location at room temperature for approximately 16.5 h.

17.5.4.5 Immediately following the third sequence, the luminaire shall be removed from the water and subjected to the dielectric voltage-withstand test of Clause [18.1](#). There shall be no dielectric breakdown, and no water shall have entered the luminaire.

### 17.5.5 UV exposure conditioning

17.5.5.1 The weatherometer test apparatus shall be in accordance with Clause [19.25](#).

17.5.5.2 Three test samples of a polymeric water shield or a polymeric material used for the enclosure of electrical equipment that will be exposed to a UV weathering source shall be acceptably resistant to degradation when exposed to:

- a) 720 h of twin enclosed carbon-arc (ASTM G 151 and G 153); or
- b) 1000 h of xenon-arc (ASTM G 151 and G 155).

17.5.5.2 (MEX) In Mexico, three test samples of a polymeric water shield or a polymeric material used for the enclosure of electrical equipment that will be exposed to a UV weathering source shall be acceptably resistant to degradation when exposed to:

- a) 720 h of twin enclosed carbon-arc (NMX-J-553-ANCE); or
- b) 1000 h of xenon-arc (NMX-J-553-ANCE).

17.5.5.3 [Table 17.5.5.1](#) summarizes the minimum property retention limitations after UV conditioning. The flammability classification of base samples of the material in the thinnest part thickness, and any color under consideration, shall not be reduced as a result of weatherometer conditioning. The average physical property values after UV conditioning shall not be less than 70 percent of the unconditioned value when the standardized small-scale physical tests indicated in [Table 17.5.5.1](#) are performed.

**Table 17.5.5.1**  
**Minimum property retention limitations after ultraviolet light and water immersion conditioning**

(See Clause [17.5.5.3](#).)

Property	Ultra-violet light*	Water immersion†
Flammability classification	Unchanged	Unchanged
Tensile or flexural strength‡	70 percent	50 percent
Tensile, izod, or charpy impact‡	70 percent	50 percent
<p>* 720 h twin enclosed carbon-arc or 1000 h xenon-arc exposure.</p> <p>† 7 d at 70 °C.</p> <p>‡ For functional support, the test methods are tensile strength and flexural strength. For impact resistance the test methods are tensile, izod, or charpy impact.</p>		

17.5.5.4 If the impact value for an enclosure material that has been tested in accordance with the requirements of Clause [17.5.5](#) has exhibited less than 70 percent but at least 25 percent retention of the impact property, it shall be considered acceptable, provided that it fulfills the following requirements:

- a) the unconditioned equipment shall comply with the resistance-to-impact requirement levels shown in [Table 17.5.5.2](#); and
- b) the specimens exposed to the 720 h twin enclosed carbon-arc UV conditioning or 1000 h xenon-arc UV conditioning have retained at least 80 percent of the 360 h twin enclosed carbon-arc UV conditioning or 500 h xenon-arc UV conditioning impact level. As an alternative, this UV conditioning may be conducted for a longer period of time in 360 h increments carbon-arc or 500 h increments for xenon-arc, provided that the final exposure impact level is not less than 80 percent of the previous increment's impact level.

**Table 17.5.5.2**  
**Unconditioned ball-impact requirements for equipment exposed to UV radiation\***

(See Clause [17.5.5.4](#).)

Retention of property after UV conditioning, percent†	Impact level for ball-impact test on unconditioned specimens, J (ft·lb)
70 or more	6.8 (5.0)
50 – 69	13.6 (10.0)
25 – 49	27.2 (20.0)
Less than 25	Not acceptable
* For other than easily moved hand-held and counter-supported equipment.	
† 720 h twin enclosed carbon-arc exposure or 1000 h xenon-arc exposure or after the final exposure if longer exposures are conducted.	

## 17.5.6 Polymeric thermal conditioning

17.5.6.1 A polymeric water shield shall be conditioned in a circulating oven for 168 h at a temperature in accordance with [Table 17.5.6.1](#) and as determined by the normal temperature test of Clause [15](#). The conditioning time may be reduced by 1/2 for each increase in oven temperature of 10 °C. If the sample is too large for the test oven, the sample may be cut to fit.

**Table 17.5.6.1**  
**Thermal conditioning exposure temperature**

(See Clause [17.5.6.1](#).)

Normal test temperature, °C	Oven test temperature, °C
65 – 75	85
76 – 85	95
86 – 95	105

17.5.6.2 The water shield shall have no obvious deterioration or deformation after conditioning.

## 17.5.7 Impact conditioning

17.5.7.1 A sample of the water shield shall be mounted on the luminaire for impact conditioning. The sample shall be subjected to a 4.1 J (3 ft·lb) impact from the steel sphere of Clause [19.21](#) from a vertical distance of 775 mm (30.5 in) on any surface of the water shield that is exposed and that can be subjected to an impact during its intended use.

17.5.7.2 The horizontal or top surface of the water shield shall be subjected to an impact from the steel sphere shown in [Figure 19.21.1](#). Other surfaces of the water shield shall be subjected to an impact from the steel sphere suspended by a cord, as shown in [Figure 19.21.2](#).

#### **17.5.8 Luminaire gasket assembly accelerated aging**

17.5.8.1 A luminaire with gaskets and bushings in place shall be subjected to the luminaire gasket assembly accelerated aging test.

17.5.8.2 The luminaire gasket assembly shall be conditioned in a circulating air oven for 240 h at 20 °C above the maximum gasket or bushing temperature as determined by the normal temperature test in Clause [15](#).

17.5.8.3 After the conditioning, any part of the luminaire that affects the sealing of the gasket assembly shall be opened. There shall be no evidence of damage to the gasket assembly, and the gasket shall remain in place. The luminaire gasket assembly shall be closed and the luminaire shall fulfill the criteria of the following tests, as applicable:

- a) the rain test of Clause [17.5.2](#);
- b) the sprinkler test of Clause [17.5.3](#); and
- c) the immersion test of Clause [17.5.4](#).

#### **17.5.9 Gasket accelerated aging (Method A)**

17.5.9.1 A gasket or bushing shall be subjected to the gasket accelerated aging test.

17.5.9.2 Three specimens of the gasket or bushing material shall be evaluated for tensile strength and elongation, and the average values calculated.

17.5.9.3 Three additional specimens shall be conditioned for 168 h in a circulating air oven at a temperature 20 °C above the maximum gasket or bushing temperature as determined by the normal temperature test of Clause [15](#).

17.5.9.4 After conditioning, the 3 specimens shall have an average tensile strength of not less than 60 percent and an average elongation of not less than 75 percent of the values determined before conditioning.

#### **17.5.10 Gasket accelerated aging (Method B)**

17.5.10.1 The test apparatus shall be in accordance with Clause [19.26](#).

17.5.10.2 Three specimens of the gasket or bushing material shall be measured to determine the average thickness.

17.5.10.3 The test weight shall be placed on the middle portion of each specimen for a period of 2 h. At the end of that time, the weight shall be removed and the specimen shall be allowed to rest at room temperature for 30 min. The average thickness of the compressed portion of the 3 specimens shall be more than 50 percent of the initial thickness.

17.5.10.4 The specimens shall be conditioned for 168 h in a circulating air oven at a temperature 20 °C above the maximum gasket or bushing temperature as determined by the normal temperature test of Clause [15](#).