



UL 33

STANDARD FOR SAFETY

Heat Responsive Links for Fire-Protection Service

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UL Standard for Safety for Heat Responsive Links for Fire-Protection Service, UL 33

Eighth Edition, Dated March 9, 2010

Summary of Topics

This revision of ANSI/UL 33 dated April 28, 2020 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated January 31, 2020.

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UL 33

Standard for Heat Responsive Links for Fire-Protection Service

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March 9, 2010

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Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover heat responsive links used for fire-protection service. These links consist of devices intended for installation under load conditions such as for use with automatic fire suppression systems; or automatic closure devices for doors, windows, dampers or smoke relief vents.

1.2 Heat responsive links are categorized by temperature rating, type of coating or plating, minimum and maximum design load, and other factors which may have a bearing on their intended use.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

5 Glossary

5.1 For the purpose of this standard, the following definitions describe various types of heat responsive links.

5.2 BI-METALLIC TYPE – Two different metals mechanically fastened together. Each metal has different expansion characteristics which act to release a load when exposed to sufficient heat. This type of device may be resettable.

5.3 FUSIBLE TYPE – Two or more metallic parts having a solder element that fuses to release a load when exposed to sufficient heat.

5.4 GLASS BULB TYPE – Liquid-filled glass bulb that fractures to release a load when exposed to sufficient heat.

5.5 HEAT RESPONSIVE LINK – A device that includes a heat responsive element and other features that allow for the application of external installation loads.

5.6 QUICK RESPONSE TYPE – A heat responsive link that complies with the applicable requirements for such links as specified in Sensitivity – Oven Heat Test, Section [11](#).

CONSTRUCTION

6 Temperature Ratings

6.1 A heat responsive link shall be constructed for service where the maximum normal ambient air temperature at the point of installation does not exceed that specified in [Table 6.1](#).

6.2 A heat responsive link shall have one of the temperature ratings specified in [Table 6.1](#).

Table 6.1
Temperature classifications and ratings

Temperature classification	Temperature ratings		Maximum ambient temperature	
	Degrees F	(Degrees C)	Degrees F	(Degrees C)
Low	125 – 130	(51 – 54)	90	(32)
Ordinary	135 – 170	(57 – 77)	100	(38)
Intermediate	175 – 225	(79 – 107)	150	(66)
High	250 – 300	(121 – 149)	225	(107)
Extra high	325 – 375	(163 – 191)	300	(149)
Very extra high	400 – 475	(204 – 246)	375	(191)
Ultra high	500 – 575	(260 – 302)	475	(246)

7 Coatings and Platings

7.1 The operation characteristics of a heat responsive link shall not be impaired by the application of any factory applied coating or plating when tested in accordance with these requirements.

7.2 A corrosion resistant coating or plating shall be uniformly applied.

7.3 A wax coating shall not be brittle when new nor become brittle with age.

7.4 A wax coating shall not crack, flake, slip, or flow when tested at the maximum temperature for which the link assembly may be installed. See High Temperature Exposure – Test for Wax Coated Heat Responsive Links, Section [13](#).

PERFORMANCE

8 Strength of Heat Responsive Element and Link Assembly Tests

8.1 Fusible-alloy and Bi-metallic Types

8.1.1 A heat responsive link assembly shall either:

- a) Sustain a load of 5 times the maximum design load for a period of 150 hours when tested in accordance with [8.1.2](#); or
- b) Demonstrate the ability to sustain the maximum design load as specified in [8.1.3](#) when tested in accordance with [8.1.4](#) and [8.1.5](#).

8.1.2 At least ten sample link assemblies of the lowest temperature rating are to be loaded to five times the manufacturer's maximum design load for 150 hours at an ambient temperature of $70 \pm 5^\circ\text{F}$ ($21 \pm 3^\circ\text{C}$). One attachment end of each sample is to be connected to the test supporting apparatus. The test load is to be applied to the other attachment end in the intended direction. All ten samples shall comply with the requirements specified in [8.1.1\(a\)](#).

8.1.3 As an alternative to the requirements specified in [8.1.2](#), a heat responsive link assembly shall support a load for 1 minute when tested as specified in [8.1.4](#); and comply with the requirements specified in [8.1.5](#).

8.1.4 At least ten sample link assemblies of the lowest temperature rating are to be loaded to five times the manufacturer's maximum design load for 1 minute at an ambient temperature of $70 \pm 5^\circ\text{F}$ ($21 \pm 3^\circ\text{C}$). One attachment end of each sample is to be connected to the test supporting apparatus. The test load is to be applied to the other attachment end in the intended direction. All ten samples shall comply with the requirements specified in [8.1.1\(b\)](#).

8.1.5 At least ten samples are to be loaded at various values in excess of the maximum design load up to 5 times the maximum design load to derive a least-square, full logarithmic regression curve of load as a function of time, from which the loads at 1 hour and 1000 hours are to be determined. At least one sample shall sustain a load for a time greater than 100 hours. The test samples are to be loaded at a conditioned temperature of $70 \pm 5^\circ\text{F}$ ($21 \pm 3^\circ\text{C}$). The maximum design load shall then comply with the following:

$$L_d \leq \frac{1.02 L_m^2}{L_o}$$

where:

L_m is the load at 1000 hours;

L_o is the load at 1 hour; and

L_d is the maximum design load.

8.2 Glass-bulb types

8.2.1 A heat responsive link assembly incorporating a glass bulb heat responsive element shall comply with the following:

- a) Sustain a load of 5 times the maximum design load for a period of 150 hours when tested in accordance with [8.1.2](#); and

b) The lower tolerance limit for bulb strength, based on calculations with a degree of confidence of 0.99 for 99 percent of samples, shall exceed twice the load applied to the bulb at maximum design load, based on calculations with the same degree of precision when tested in accordance with [8.2.2](#).

8.2.2 The bulb strength is to be measured by applying a steadily increasing load, using a compression testing machine, until the bulb breaks or fractures. This test is to be conducted with the bulb mounted in the seating parts used in the assembly and the load is to be applied at a rate not exceeding 55 pounds-force per second (245 N/s) or at a rate the deflects the bulb 0.02 inch (0.51 mm) per minute, whichever measurement is convenient for the test apparatus being used. Bulb seatings may be reinforced circumferentially in a manner not interfering with the bulb breakage. A minimum of 15 samples of each temperature rating and each bulb type are to be tested. Calculations are to be based on the Normal or Gaussian Distribution except where another distribution can be shown to be more applicable due to manufacturing or design factors. See Appendix [A](#).

9 Glass-Bulb Thermal Shock Test

9.1 A glass bulb type heat responsive element assembly shall withstand the thermal shock of rapid temperature changes having a range from 20°F (11°C) less than its rated operating temperature to 50°F (10°C). At least five sample bulbs are to be conditioned for 5 minutes in a liquid bath at 20°F (11°C) less than the rated operating temperature. The samples then are to be removed and immediately submerged in another liquid bath at 50°F. There shall be no breakage or fracture of the glass bulb.

10 Operating Temperature (Bath) Test

10.1 The operating temperature of heat responsive links, when bath tested, shall operate within the range having a maximum temperature not in excess of 10°F (5°C) or 107 percent of the minimum Fahrenheit temperature of the range, whichever is greater. For the purpose of this determination, the marked temperature rating is to be included as one of the ranged values, making a total of 11 values in the range. [Table 6.1](#) defines temperature ratings.

10.2 Link operation for this test includes the intended functioning of the eutectic elements or any rupture of the glass bulb heat responsive element. If partial fracture of the glass bulb in the liquid environment occurs which does not result in link operation, the temperature at which the bulb fracture occurred shall be considered the operating temperature.

10.3 Not less than ten heat responsive links of both coated and uncoated types of each temperature rating are to be subjected to this test. All ten samples shall comply with the requirements of [10.1](#).

10.4 The heat responsive links are to be placed in an upright position under a load equal to the manufacturer's minimum design load, but not less than 1 pound-force (4 N), and completely immersed in the water or oil bath. The bath vessel is to be provided with a source for heating the liquid at the prescribed rate and with means to agitate the liquid and measure the temperature of the liquid bath.

10.5 Water is to be used in bath tests of heat responsive links which have operating temperature ratings of 175°F (79°C) or lower. Samples having operating temperature ratings of 176 to 575°F (80 to 302°C) are to be bath-tested in an oil having a flash point exceeding the test temperature.

10.6 An agitator is to be used as an aid in obtaining uniformity in temperature of the liquid in the bath.

10.7 A calibrated temperature-measuring device is to be used to determine temperature of the liquid in bath tests. The sensing element of the temperature measuring device is to be held level with the heat responsive link by a support member.

10.8 The temperature of the bath liquid is to be raised until the liquid is within 20° F (11° C) of the temperature rating of the device for a device having a temperature rating of 300° F (149° C) or less, and within 30° F (17° C) for a device having a temperature rating of 325° F (163° C) and higher. The temperature rise then is to be controlled at a rate not exceeding 1° F (0.5° C) per minute until operation or until a temperature 20° F (11° C) above the rated temperature is reached. The temperature of the liquid and the time of operation, as each heat responsive link operates, are to be recorded.

11 Sensitivity – Oven Heat Test

11.1 A link shall have the following operating time characteristics when tested in the sensitivity test oven as specified in [11.2](#) – [11.5](#):

- a) For a QR link, each sample shall have a maximum operating time as specified in [Table 11.1](#). If the link temperature rating is not shown in [Table 11.1](#), the maximum operating time for each sample is to be determined by using the formula specified in [11.5](#) based on a Response Time Index (RTI) value of $50 \text{ (m}\cdot\text{s)}^{1/2}$ [$90 \text{ (ft}\cdot\text{s)}^{1/2}$], and the marked temperature rating of the link.
- b) For a standard response link, each sample shall have a maximum operating time as specified in [Table 11.1](#). If the link temperature rating is not shown in [Table 11.1](#), the maximum operating time for each sample is to be determined by using the formula specified in [11.5](#), based on a RTI value of $350 \text{ (m}\cdot\text{s)}^{1/2}$ [$630 \text{ (ft}\cdot\text{s)}^{1/2}$] and the marked temperature rating of the link.
- c) The mean operating time shall be equal to or less than a 1.30 multiple of the mean operating time of the link tested in accordance with (a) and (b) after being subjected to the exposure tests specified in Section [15](#), 10-Day Corrosion Test, and Section [16](#), 30-Day Corrosion Test.

Table 11.1
Operating time for links in sensitivity-oven heat test

Temperature rating		Oven temperature		Quick response type, seconds	Standard response type, seconds	Coated standard response type, seconds ^a
°F	(°C)	°F	(°C)	Max.	Max.	Max.
135	(57.2)	275	(135)	11.2	78.0	180
140	(60.0)	275	(135)	12.3	86.1	180
155	(68.3)	275	(135)	12.3	86.1	180
160	(71.1)	275	(135)	17.4	121.3	180
165	(73.9)	275	(135)	18.8	131.1	180
175	(79.4)	386	(197)	12.1	84.8	180
200	(93.3)	386	(197)	16.1	112.4	180
212	(100.0)	386	(197)	18.2	127.1	180
220	(104.4)	386	(197)	19.6	137.3	180
250	(121.1)	555	(291)	14.3	99.3	180
286	(141.1)	555	(291)	18.1	126.8	180
300	(148.9)	555	(291)	19.8	138.5	180
360	(182.2)	765	(407)	16.7	117.0	180
400	(204.4)	765	(407)	20.0	139.9	180
450	(232.2)	765	(407)	24.6	172.3	180
500	(260.0)	765	(407)	30.0	210.3	210.3

^a Corrosion resistant links with coated heat responsive elements including wax, lead, Teflon, wax over lead, and polyester coating. Coated quick response links shall comply with [11.1\(a\)](#).

Table 11.2
Sensitivity oven temperatures

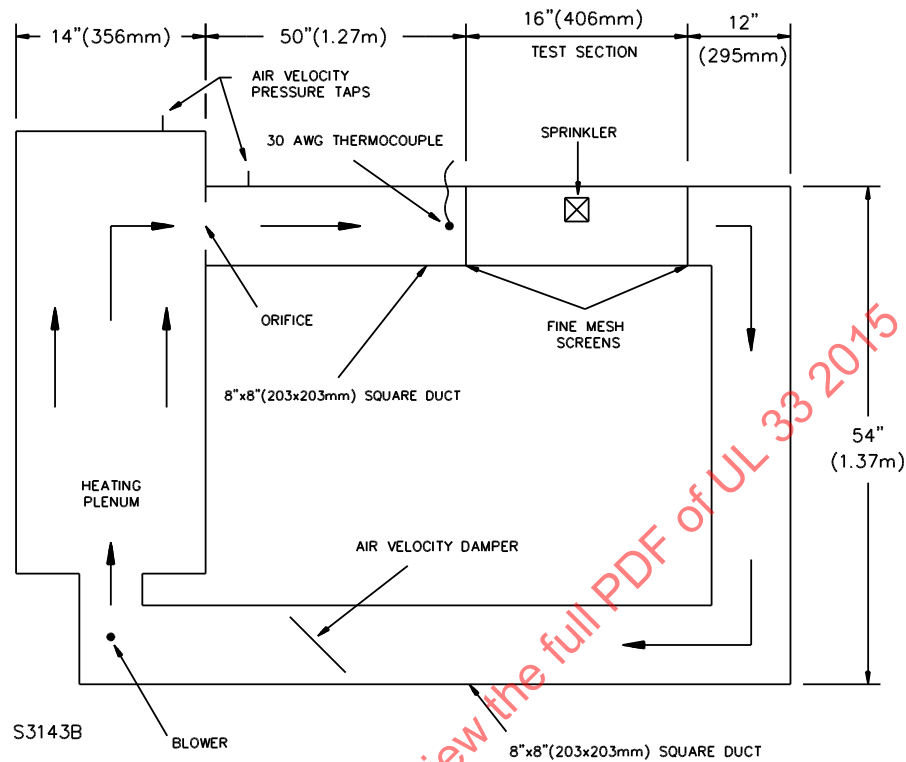
Temperature rating		Oven temperature	
°F	(°C)	°F $\pm 2^\circ\text{F}$	(°C $\pm 1^\circ\text{C}$)
135 – 170	(57 – 77)	275	(135)
175 – 225	(79 – 107)	386	(197)
250 – 300	(121 – 149)	555	(290)
325 – 375	(163 – 191)	765	(407)
400 – 475	(204 – 246)	765	(407)
500 – 575	(260 – 302)	765	(407)

11.2 Ten samples of heat responsive links of each type are to be placed in the sensitivity test oven with the heat responsive element located at least 1 inch (25.4 mm) away from the inside surfaces of the oven and with the broadest part of the link, or with the heat responsive element of the link, facing toward the air flow. The samples are to be at the minimum load specified by the manufacturer.

11.3 The samples are to be conditioned at $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$) for at least 2 hours. The samples are then to be quickly plunged into the sensitivity test oven in the vertical position. Each link is to be observed to determine if operation occurs within the time specified in [11.1](#).

11.4 The sensitivity test oven is to consist of an 8-inch (203-mm) square stainless steel chamber as shown in [Figure 11.1](#). A constant air velocity of 8.33 ± 0.05 feet per second (2.54 ± 0.01 m/s) and an air temperature as specified in [Table 11.2](#) for each temperature rating are to be established. Air velocity is to be measured using an orifice plate and a manometer or a bidirectional probe and a velometer. The air temperature is to be measured by use of a 30 AWG (0.05 mm^2) thermocouple centered upstream from the sample as shown in [Figure 11.1](#).

Figure 11.1
Sensitivity test oven



11.5 The required link operating time values specified in [11.1](#) shall be calculated by using the following equation:

$$t_o = \frac{-RTI * \ln \left[1 - \left[\frac{(T_m - T_u)}{T_g - T_u} \right] \right]}{\sqrt{u}}$$

Where:

RTI is Response Time Index [(m·s)^{1/2}; (ft·s)^{1/2}]

t_o is Operating time of the link [s]

u is Nominal gas velocity in the test section of the wind tunnel [2.54 m/s; 8.33 ft/s]

T_m is Marked temperature rating of the link [°C; °F]

T_g is Nominal gas temperature in test section in [Table 11.2](#) [°C; °F]

T_u is Nominal ambient air temperature [24°C; 75°F]

12 High Temperature Exposure – Test (90-Day) Heat Responsive Links

12.1 A heat responsive link not having a wax coating shall withstand the maximum design load for 90 days, without evidence of weakness or operation, an exposure to the temperature specified in [Table 12.1](#).

After the exposure, each heat responsive link shall comply with the Sensitivity – Oven Heat Test, Section [11](#).

12.2 An automatically controlled, circulating-type, constant-temperature oven is to be used for this test. Five previously untested heat responsive links of each operating temperature are to be placed in an oven at the specified temperature and under the maximum design load.

12.3 Each sample is to be examined weekly for weakness as evidenced by its inability to withstand the load for the test duration.

Table 12.1
High-temperature exposure test conditions

	Temperature rating		Test temperature	
	Degrees F	(Degrees C)	Degrees F ($\pm 2^{\circ}\text{F}$)	(Degrees C) ($\pm 1^{\circ}\text{C}$)
Low	125 – 130	(52 – 54)	110	(43)
Ordinary	135 – 140	(57 – 60)	120	(49)
	141 – 170	(61 – 77)	125	(52)
Intermediate	175 – 195	(79 – 91)	155	(68)
	196 – 225	(91 – 107)	175	(79)
High	250 – 270	(121 – 132)	230	(110)
	271 – 300	(133 – 149)	250	(121)
Extra high	325 – 375	(163 – 191)	300	(149)
Very extra high	400 – 474	(204 – 246)	375	(191)
Ultra high	500 – 575	(260 – 302)	475	(246)

13 High Temperature Exposure – Test for Wax Coated Heat Responsive Links

13.1 A wax coated heat responsive link shall withstand the maximum design load, for 90 days without evidence of weakness, operation, or exposure of the base material, an exposure to the maximum ambient temperature specified in [Table 6.1](#). Following the exposure, the coating shall not show evidence of deterioration such as cracking, flaking, or flowing. After the exposure, each heat responsive link shall comply with the Sensitivity – Oven Heat Test, Section [11](#).

13.2 An automatically controlled, circulating-type, constant-temperature oven is to be used for this test. Five previously untested heat responsive links with each type of coating are to be placed in the oven, the air of which is to be maintained constantly at the specified temperatures.

13.3 Each sample is to be examined weekly for wax coating degradation or link weakness as evidenced by its inability to withstand the load for the test duration.

14 Evaporation Test for Wax Coatings

14.1 When tested as specified in [14.3](#), a protective coating containing volatiles such as wax or similar material shall not shrink, harden, crack, or flake.

14.2 When tested as specified in [14.3](#), the loss of volatiles in a wax coating shall not exceed 5 percent of the weight of the original sample.