15.7 Flame detector operating characteristics and proved igniters

Replacement:

The operating characteristics of flame detectors and proved igniter operating value shall be measured under the following conditions:

a) at V_R and 77 ±10°F (25 ±5.5°C); and

b) at 0.85 V_R and 32°F (0°C) or T_{min}, whichever is lower; and

c) at 1.1 V_R and 140°F (60°C) or T_{max}, whichever is higher.

The measured values shall be within the declarations of S_1, S_2 and S_{max} (if applicable).

The details of the measuring equipment shall be arranged between the manufacturer and test agency.

16 Not Applicable

17 Endurance

17.1.1 Controls, including those submitted in or with an equipment, shall withstand, without excessive wear or other harmful effect, mechanical, electrical and thermal stresses that occur in normal use.

17.1.2 Addition:

Compliance is checked by the tests indicated in 17.1.3.

For thermo-electric and system components other than electronic or electro-mechanical, tests referenced in clause 29A shall be conducted.

17.1.3 Test sequence and conditions

Replacement:

In general the sequence of tests is:

– for overload test of electronic and electro-mechanical controls as specified in 17.2.3.

– for electronic controls only, the thermal cycling test specified in 17.16.101;

– endurance test of electronic and electro-mechanical controls as specified in 17.16.102;

– vibration test of 17.16.103, if declared;

For test conditions, see 17.2 and the relevant tests of 17.16.

The number of operations performed during 17.16.101 and 17.16.102 is recorded. When the actual number of automatic cycles completed is equal to 100,000, this test sequence is concluded and the following performed.

– Vibration test of 17.16.103, if declared;

– Lock-out reset test of 17.16.105;

– electrical strength requirements specified in 17.16.107;

– evaluation of compliance specified in 17.16.108.

17.1.4 Not Applicable.

17.2 Electrical conditions for tests

17.2.1 Replacement:

Each circuit of the control shall be loaded according to the ratings declared by the manufacturer. Circuits and contacts which are not intended for external loads are operated with the designed load.

17.2.2 Not Applicable.

Table 17.2.1 Not Applicable

17.2.5 Not Applicable.

17.3 Thermal conditions for tests

17.3.1 The overload test shall be conducted at T_{max} + 9°F (T_{max} + 5°C) or 1.05 times T_{max}, whichever is greater.

17.4 to 17.6 Not Applicable.

17.7.3 Replacement:

The method and rate of operation shall be agreed between the testing agency and the manufacturer.

17.7.4 to 17.7.6 Not Applicable.

17.7.7 Replacement:

The number of cycles is 50.

17.8 to 17.15 Not Applicable

Table 17.2.2 – Electrical conditions for the tests of 17.2.1 (overload test)

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	V
Substantially resistive (classified 6.2.1)	Making and breaking	V_T	1.5 I_R	1.0	V_T	1.5 I_R
Inductive (non-motor)	Making and breaking	V_T	1.5 I_X	0.75–0.8	V_T	1.5 I_X
Declared motor load (classified 6.2.5)	Making and breaking	V_T	6 I_m or as declared	0.4–0.5	V_T	10 I_m or as declared
Pilot duty load (classified 6.2.6)	Making	1.1 V_T	11 VA/V_T	0.35 maximum	As declared	
	Breaking	1.1 V_T	1.1 VA/V_T			

The following abbreviations are used:

V_R is the rated voltage, V_T is the test voltage (see 17.2.3.1).

I_m is the rated current for motor load, I_R is the rated current for resistive load, I_X is the rated current for induction load.

NOTE – For test purposes a pilot duty load consists of an electromagnet representative of the magnet coil which is to be controlled. The normal current is that determined from the voltage and volt-ampere ratings of the electromagnet. The test current is the normal current and for an alternating current the power factor is to be 0.35 or less and the inrush current is to be ten times the normal current. The test contactor is to be free to operate i.e., not blocked by either the open or the closed position.

An alternating-current pilot duty rating may be determined for a control which has been tested for controlling an alternating-current motor on the following basis:

– during the overload test, the control was caused to make and break, for 50 cycles at a rate of 6 cycles per minute, a current having a value equivalent to six times the full-load motor current at a power factor of 0.5 or less, and

– the pilot duty inrush current rating (ten times the normal current rating) is to be not more than 67% of the current value for the overload test described above.

Table 17.2.3 – Electrical conditions for the tests of 17.16

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	A
Substantially resistive (classified 6.2.1)	Making and breaking	V_T	I_R	1.0	V_T	I_R
Inductive (non-motor)	Making and breaking	V_T	I_X	0.75–0.8	V_T	I_X
Declared motor load (classified 6.2.5)	Making and breaking	V_T	I_m	0.75–0.8	V_T	I_m
Pilot duty load (classified 6.2.6)	Making	V_T	10 VA/V_T	0.35 maximum	–	
	Breaking	V_T	VA/V_T			

The following abbreviations are used:

V_R is the rated voltage, V_T is the test voltage (see 17.2.3.1).

I_m is the rated current for motor load, I_R is the rated current for resistive load, I_X is the rated current for induction load.

NOTE – For test purposes a pilot duty load consists of an electromagnet representative of the magnet coil which is to be controlled. The normal current is that determined from the voltage and volt-ampere ratings of the electromagnet. The test current is the normal current and for an alternating current the power factor is to be 0.35 or less and the inrush current is to be ten times the normal current. The test contactor is to be free to operate i.e., not blocked by either the open or the closed position.

Table 17.2.3 – Electrical conditions for the tests of 17.16 Continued on Next Page

Table 17.2.3 – Electrical conditions for the tests of 17.16 Continued

Type of circuit	Operation	A.C. circuit			D.C. circuit	
		V	A	Power factor	V	A
An alternating-current pilot duty rating may be determined for a control which has been tested for controlling an alternating-current motor on the following basis: – during the overload test, the control was caused to make and break, for 50 cycles at a rate of 6 cycles per minute, a current having a value equivalent to six times the full-load motor current at a power factor of 0.5 or less, and – the pilot duty inrush current rating (ten times the normal current rating) is to be not more than 67% of the current value for the overload test described above.						

17.16 Tests for particular purpose controls

17.16.101 Thermal cycling test for electronic controls only

Electrical conditions for this test shall be per Table 17.2.3, unless otherwise specified.

The purpose of the test is to cycle components of an electronic circuit between the extremes of temperature likely to occur during normal use and which may result from ambient temperature variation, supply voltage variation, or the change from an operating condition to a non-operating condition and vice-versa.

The following conditions shall form the basis of the test:

a) Duration of test: 14 days

b) Electrical conditions

The control is loaded according to the ratings declared by the manufacturer, the voltage then being increased to 1.1 V_R, except that for thirty minutes during each 24 hour period of the test the voltage is reduced to 0.9 V_R. The change of voltage shall not be synchronized with the change of temperature. Each 24 hour period shall also include at least one period in the order of 30 seconds during which the supply voltage is switched off.

c) Thermal conditions

The ambient temperature is varied between T_{max} and T_{min} to cause the temperature of the components of the electronic circuit to be cycled between their resulting extremes. The rate of ambient temperature change shall be in the order of 2°F/minute (1°C/minute) and the extremes of temperature maintained for approximately 1 hour.

d) Rate of operation

During the test the control shall be cycled through its operational modes at the fastest rate possible up to a maximum of six cycles/minute subject to the need to cycle components between their temperature extremes.

Care shall be taken to avoid the occurrence of condensation during this test.

17.16.102 Endurance test of electronic and electro-mechanical systems at normal operating rate

17.16.102.1 Test sequence and conditions:

The test is carried out with the terminals loaded with the maximum rated current.

The system and its flame detector are tested under the following conditions:

a) 45,000 operations at V_R and 77 ±10°F (25 ±5.5°C) for electronic controls;

If the control is electro-mechanical, this test is performed at T_{max}.

b) 2,500 operations at T_{max} and 1.1 V_R or 1.1 times the upper limit of the rated voltage range;

c) 10,000 operations for electro-mechanical controls and 2,500 operations for electronic controls at T_{min} and 0.85 V_R or 0.85 times the lower limit of the rated voltage range for a.c. and 0.80 V_R or 0.80 times the lower limit of the rated voltage range for d.c.

d) The remaining number of required cycles shall be conducted at V_R, I_R and T_{max}.

17.16.103 Vibration test

Controls declared in Table 7.2, requirement 122 are subjected to the vibration test of IEC 60068-2-6 as follows:

Cycling rate:	as declared
Loaded at:	1.1 V_R
Frequency range:	10 – 150 Hz
Acceleration amplitude:	1g or higher if declared by the manufacturer
Sweep rate:	1 octave/minute
Number of sweep cycles:	10
Number of axes:	3, mutually perpendicular

17.16.104 Not Applicable.

17.16.105 Lock-out reset test

Tests shall be conducted at V_R, I_R and T_{max} with the same control sample as used in 17.16.101 and 17.16.102.

The control is also tested under the following lock-out conditions, mounted as declared in Table 7.2 requirement 31, for a total of 6,000 cycles.

– 3,000 cycles with the flame disappearing; and

– 3,000 cycles without flame presence.

The control is operated in such a way that the normal start-up sequence is performed.

The repetition of the sequence shall be compatible with the method of operation and shall be dependent on the cycling rate, if any, declared by the manufacturer.

17.16.105A *Addition of requirements covering continuous lockout for electro-mechanical controls and the method of test:*

Tests may be conducted with a new sample.

Timings shall not be adversely affected by prolonged energization of the lockout means.

One of the devices tested for compliance with clause 15, Manufacturer Deviation and Drift, shall be installed in an unheated test chamber and protected from drafts and extraneous sources of heat. The device shall be energized at 1.1 V_R for 48 hours.

At the end of this period, the device shall be deenergized for at least 1 hour. The lockout timing shall then be determined as specified in item c of 15.5. The readings shall not exceed the manufacturer's specified maximum Lockout Time (Table 7.2 item 114).

17.16.106 Test for particular purpose controls (See 29A, Construction/Performance for Pilot Burners, Oxygen Depletion Safety Shutoff Systems (DS) and Other Components.)

17.16.106.1 Not Applicable.

17.16.107 Electric strength requirements

After the tests of 17.16.101 to 17.16.105A, the requirements of 13.2 shall apply, with the exception that the samples are not subjected to the humidity treatment before the application of the test voltage.

17.16.108 Evaluation of compliance

After completion of all the applicable tests of 17.16.101 to 17.16.107 inclusive, the sample shall be retested according to Clause 15, Manufacturer Deviation and Drift. The operating times, operating sequence, flame detector characteristics and proved igniter operating value shall be as declared in Table 7.2.

18 Mechanical strength

18.1 General requirements

18.2 Impact resistance

18.2.1 For independently mounted controls, except as provided in 18.4 are checked by applying blows to the sample by means of the apparatus in IEC 60068-2-75, Environmental testing – Part 2-75: Tests Eh: Hammer tests, or the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations UL 746C, or CSA C22.2 No. 0.17, the Standard for Evaluation of Properties of Polymeric Materials.

The impact resistance of controls constructed of polymeric materials is determined during test in UL 746C or CAN/CSA C22.2 No. 0.17. The impact resistance of controls constructed of metallic materials is determined as indicated in 18.4.

18.2.4.1 Not Applicable.

18.4 Alternate compliance – Impact resistance

18.4A *Addition:*

A sheet-steel transformer enclosure shall have a thickness of not less than 0.026 inch (0.66 mm) if uncoated and not less than 0.029 inch (0.74 mm) if galvanized.

18.4A.1 *Addition:*

Sheet steel having a thickness of not less than 0.020 inch (0.51 mm) if uncoated and not less than 0.023 inch (0.58 mm) if galvanized may be used for a drawn end bell having maximum dimensions of 2-1/4 inches (57.2 mm) on the flat portion and 1-1/2 inches (38.1 mm) at the base of the drawn portion.

Table 18.4.1 *Modify the notes to Table 18.4.1 in the Part 1 as follows:*

At points at which a wiring system is to be connected, uncoated steel shall not be less than 0.032 inch (0.81 mm) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 mm) thick.

Table 18.4.2 *Modify the notes to Table 18.4.2 in the Part 1 as follows:*

At points at which a wiring system is to be connected, nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick.

18.5 through 18.8 Not Applicable

18.9 Actuating member and actuating means

18.9.1 through 18.9.3 Not Applicable.

18.9A *Addition:*

For a control that is operated by a push, pull, slide, toggle, or lever adjustment, a force is to be applied to the free end of the adjustment in line with the intended movement in each direction of operation. The force is to be 20 pounds (89 N) for a commercial or industrial control and 10 pounds (45 N) for a residential control. A separate sample is to be used for each test.

18.9A.1 A control adjustment operated as described in paragraph 18.9A and intended for use with an extended operator, handle, or lever is to be tested with an in-line force applied to the free end of an extension representing the intended end-use application.

18.9A.2 For a control that is operated by a rotary adjustment intended for use with a knob having a grip diameter or grip length of 1 inch (25.4 mm) or less, a torque is to be applied to the shaft in each direction of intended operation. The torque is to be 9 pound-inches (1.0 N·m) for a commercial or industrial control and 7 pound-inches (0.8 N·m) for a residential control. A separate sample is to be used for each test.

18.9A.3 A control that is operated by a rotary adjustment intended for use with a knob having a grip diameter or grip length of more than 1 inch (25.4 mm) is to be subjected to a torque that is proportionally greater than that specified in paragraph 18.9A.2, based on the larger grip diameter or grip length of the knob used; the value for the torque to be used is to be determined by the formula:

$$T = (D_1/D)K$$

in which:

T – the test torque in pound-inches (N·m)

D_1 – the grip diameter or grip length, as applicable in inches (mm)

D – 1 inch (25.4 mm)

K – 9 pound-inches (1.0 N·m) for a commercial or industrial control, or 7 pound-inches (0.8 N·m) for a residential control.

18.9A.4 If a lever arm is intended to be attached to a rotary-control shaft, the assembly is to be tested as described in 18.9A.1 with the force applied to the free end of the lever.

18.10A *Addition:*

18.10A.1 Windows

Glass covering an observation opening shall be reliably secured in place so that it cannot be readily displaced in service, and shall provide mechanical protection for the enclosed parts.

18.10A.2 Glass for an opening not more than 4 inch (101.6 mm) in any dimension shall not be less than 1/16 inch (1.6 mm) thick, and glass for a larger opening, but not more than 144 in^2 (929 cm^2) in area and having no dimension greater than 12 inch (304.8 mm), shall not be less than 1/8 inch (3.2 mm) thick. Glass that covers a larger area shall not be less than 1/8 inch (3.2 mm) thick and shall withstand a 2-1/2 foot-pound (2.41 J) impact from a 2 inch (50.8 mm) diameter, 1.18 pound (535 g) steel sphere without cracking or breaking to the extent that a piece is released or dropped from its normal position.

18.10A.3 A transparent material other than glass employed as a covering over an opening in an enclosure shall be investigated to determine if it has adequate mechanical strength and shall be investigated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or the Standard for Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17.

19 Threaded parts and connections

19.1.9 Not Applicable.

19.1.10 The clause of Part 1 is applicable with the following addition:

The tests of 19.1.11 to 19.1.15 are not applicable to metal screws in engagement with a thread of metallic material.

19.2 Current-carrying connections

Modification:

Delete fourth note to 19.2.2.

20 Creepage distances, clearances and distances through insulation

20.1 Replacement:

The creepage distances and clearances shall not be less than the appropriate value in Tables 20.3.2 to 20.3.4, inclusive.

20.1.1 through 20.1.10 Not Applicable.

Table 20.1 Not Applicable.

20.2 Not Applicable.

20.3 Modification:

Delete first paragraph.

20.3.1 Replacement:

The creepage distances and clearances shall not be less than the appropriate values in one of the following tables:

20.3.2 Replacement:

Compliance with 20.3.1 is checked by measurement, using the method of measurement given in Figure 17, Measurement of Crepage and Clearance, and Annex B, Measurement of creepage distances and clearances in air.

20.3.A.3 Addition:

The required dimensions which result from the tables minimum values must be maintained, both during production and during the expected life of the equipment.

Table 20.3.1 Void

Addition:

Table 20.3.2 – Creepage and clearance distances

Distance under consider-ation	Dimensions in inches (mm) required for working volts [1) 5) 9) 12)]									
	Up to 50 V		Over 51 V and up to 150 V		Over 151 V and up to 300 V		Over 301 V and up to 450 V		Over 451 V and up to 600 V	
	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance
Operational insulation										
Over 2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)
0–2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	– –	– –	– –	– –
Basic insulation										
Over 2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)
0–2000 VA	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	0.25 (6.4)	0.125 (3.2)	– –	– –	– –	– –
Between any energized part and the enclosure including fittings										
Over 2000 VA	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)
0–2000 VA	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)	0.5 (12.7)
Between terminals for fixed wiring and between a terminal and grounded metal excluding an enclosure	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.25 (6.4)	0.37 (9.5)	0.25 (6.4)	0.5 (12.7)	0.37 (9.5)	0.5 (12.7)	0.37 (9.5)

1) If the working voltage across creepage distances and clearances for other than operational insulation is less than the rated voltage of the control, the working voltage is assumed to be equal to the rated voltage.

2) If the contact member is of the same material and design as the actual contact, the contact member is considered to be part of the contact.

Table 20.3.2 – Creepage and clearance distances Continued on Next Page

Table 20.3.2 – Creepage and clearance distances Continued

Distance under consider-ation	Dimensions in inches (mm) required for working volts [1) 5) 9) 12)]									
	Up to 50 V		Over 51 V and up to 150 V		Over 151 V and up to 300 V		Over 301 V and up to 450 V		Over 451 V and up to 600 V	
	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance	Creepage	Clearance

3) Not Applicable.

4) The creepage distance and clearance to a metal enclosure do not apply to the frame of a control intended for installation within an equipment housing.

5) For controls the creepage distance and clearance between terminals for connection to fixed wiring of opposite polarity between such a terminal and an earthed or an accessible dead metal part shall not be less than ¼ inch (6.4 mm) if short-circuiting or earthing of such terminals may result from projecting strands of wire.

6) This table applies to low voltage controls if a short-circuit between parts in such a control may result in unsafe operation of the controlled equipment.

7) The creepage distance and clearance on opposite sides of a switching mechanism are creepage distance 1/16 inch (1.6 mm) and clearance 1/32 inch (0.8 mm) except at the contact points and except as noted for low voltage and isolated limited secondary circuits.

8) These values do not apply at the contact points.

9) The creepage distance and clearance between terminals for connection of fixed wiring regardless of polarity and between such a terminal and a dead metal part (including the enclosure which may be grounded when the device is installed) shall not be less than ¼ inch (6.4 mm) or larger where specified in the table.

10) This table applies to controls used in isolated limited secondary circuits if short-circuiting between parts in such a control regardless of polarity will not result in abnormal operation of the controlled equipment. These values apply only to spacings between components of the circuit under consideration, or between these components and dead metal. No reduction of spacings to other circuits of combination equipment is acceptable. If abnormal operation results from short-circuiting of parts involved, general spacings apply.

11) Not Applicable.

12) This table does not apply to low voltage.

13) Not Applicable.

14) Not Applicable.

15) Not Applicable.

16A) In measuring a spacing between a live part and a bushing installed in a knockout, it is to be assumed that a bushing, having a dimension in Table 20.3.4A, is in place and that a single locknut is installed on the outside of the enclosure.

Addition:

Table 20.3.3 – Creepage and clearance distances for low voltage, 100 volt-ampere maximum, Inches (mm) [6)]

Distance under consideration	0 V to 30 V	
	Creepage	Clearance
Operational insulation	0.031 (0.8)	0.031 (0.8)
Basic insulation	0.031 (0.8)	0.031 (0.8)
Across micro-interruption [2) 8)]	0.031 (0.8)	0.031 (0.8)
Between any energized part and the enclosure [4) 16A)]	0.125 (3.2)	0.125 (3.2)
Between a terminal for fixed wiring and the enclosure or a dead metal part which may be grounded when installed	0.25 (6.4)	0.25 (6.4)
Between terminals for fixed wiring	0.25 (6.4)	0.25 (6.4)

1) If the working voltage across creepage distances and clearances for other than operational insulation is less than the rated voltage of the control, the working voltage is assumed to be equal to the rated voltage.

2) If the contact member is of the same material and design as the actual contact, the contact member is considered to be part of the contact.

3) Not Applicable.

Table 20.3.3 – Creepage and clearance distances for low voltage, 100 volt-ampere maximum, Inches