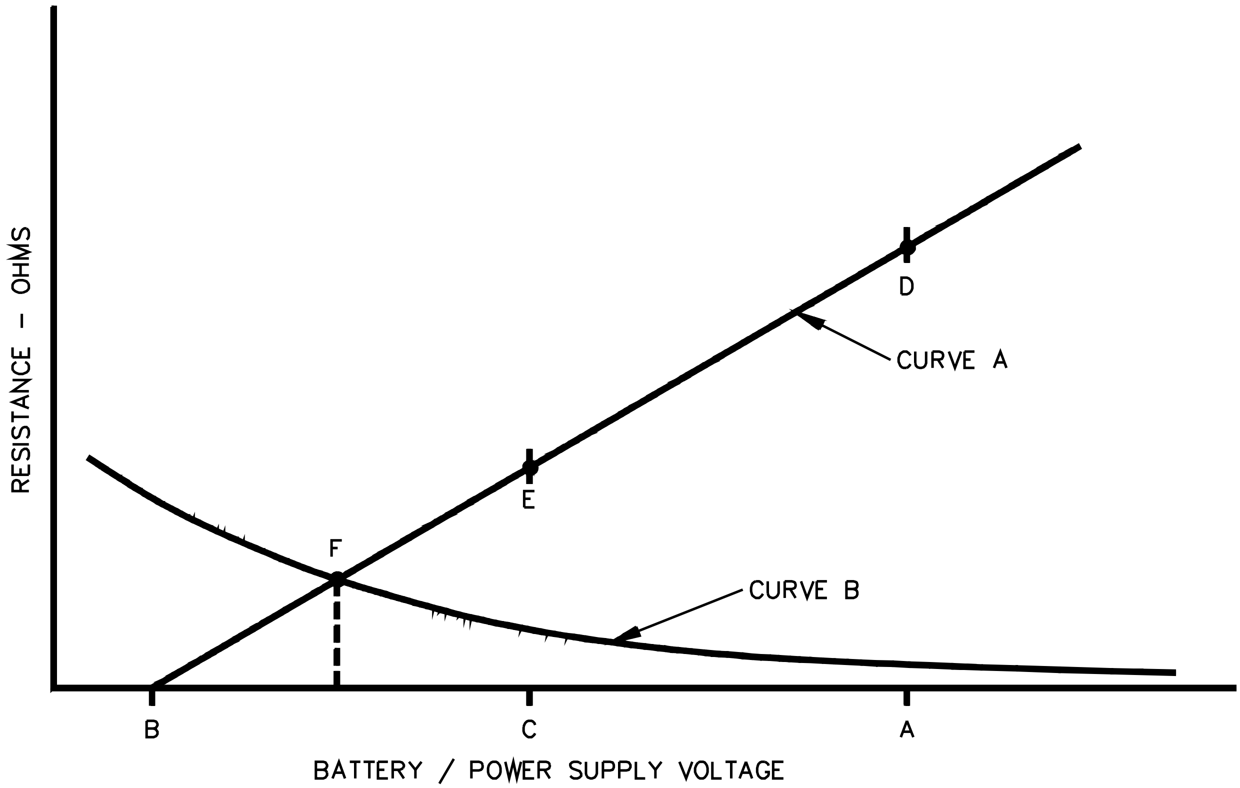
Figure 44.2
Trouble level determination



S2479

A – Rated battery voltage

B – Trouble level voltage (assuming minimal resistance)

C – Voltage value between rated and trouble level

D – Trouble level resistance at rated battery voltage

E – Trouble level resistance at voltage value C

F – Maximum permissible battery resistance and minimum voltage after 1 year in long-term battery test

Curve A – Sample plot of voltage versus resistance (Alarm Trouble Level Curve) at which a trouble signal in an alarm is obtained. Audibility measurement is to be made at points between D and F

Curve B – Sample plot of battery internal resistance versus battery open circuit voltage derived from long term (minimum 1 year) battery test. Shape and slope of curve, as well as point of intersection with Curve A, varies based on battery used

44.2.3 To determine compliance with 44.2.1 each of three alarms is to be connected in series with a variable regulated direct current power supply and a variable resistor as illustrated in Figure 44.1. The trouble level is to be determined by the following steps:

a) Rated Battery Voltage – The voltage of the power supply is to be set at the rated battery voltage and the series resistor at 0 ohm. The resistor is to be increased in increments of 0.1 – 10 ohms, at a rate of not more than one increment per minute, until a trouble signal is obtained. The alarm is to be tested for alarm operation at each resistance level and at the trouble signal level.

b) Trouble Level Voltage – With the variable resistor set at 0 ohm, the voltage of the power supply connected to the alarm is to be reduced in increments of 1/10 volt per minute to the level where the trouble signal is obtained. The alarm is to be tested for alarm operation at each voltage level and at the trouble signal level.

c) Voltage Values Between Rated and Trouble Level Voltages – The voltage of the power supply is to be set at pre-specified voltages between the rated battery voltage and the trouble level voltage. The series resistor is then to be increased in increments of 0.1 – 10 ohms, at a rate of not more than one increment per minute, until a trouble signal is obtained. The alarm is to be tested for alarm operation at each resistance and voltage level and at the trouble voltage level. A number of voltage values shall be used to determine the shape of the trouble level curve.

44.2.4 To determine that a battery is capable of supplying alarm and trouble signal power to the alarm for at least the manufacturer's specified battery life (1 year minimum) under the room ambient condition described in the Battery Tests, Section 59, Curve A of Figure 44.2 is to be plotted from the data obtained in the measurements described in 44.2.3 and compared to Curve B of Figure 44.2, which is plotted from data generated in the 1 year battery test. The intersection of Curves A and B shall not occur before the manufacture's specified battery life (1 year minimum) and all points of Curve B to the right of point F (extended to the base line), shall be below Curve A.

45 Overvoltage and Undervoltage Tests

45.1 Overvoltage test

45.1.1 An alarm other than one operating from a main battery power supply shall operate as intended in the standby condition while performing its signaling function and connected to a supply source of 110 percent of rated value. When a nominal rated voltage value is specified, the overvoltage shall be 110 percent of the test voltage specified in 42.1. When an operating voltage range is specified, the overvoltage shall be either 110 percent of the high value of the voltage range or 110 percent of the test voltage specified in Section 42, Test Voltages, whichever is higher. While energized from the overvoltage condition, the response of a unit shall not show a time variation of more than 50 percent from the value obtained in the Oven Test, Section 26, on as-received samples.

45.1.2 For alarms intended for connection in a multiple station configuration, the minimum number of alarms specified by the installation instructions are to be interconnected with zero line resistance between alarms and tested for their intended operation.

45.1.3 For operation at the higher voltage, three alarms are to be subjected to the specified increased voltage in the standby condition for at least 16 hours, or as specified by the manufacturer, and then tested for their intended signaling operation and sensitivity.

45.2 Undervoltage test

45.2.1 An alarm shall operate for its intended signaling performance while energized from a supply of 85 percent of the test voltage specified by the manufacturer. For units powered from a primary battery, the test shall be conducted at the battery trouble signal voltage level. While energized from the undervoltage condition, the response of a unit shall not show a time variation of more than 50 percent from the value obtained in the Oven Test, Section 26, on as-received samples.

45.2.2 For alarms intended for connection in a multiple station configuration, the maximum number of alarms specified by the installation instructions are to be interconnected with either 10 ohms resistance between alarms, or the maximum resistance specified in the installation instructions, and tested for intended operation.

45.2.3 When the alarm is provided with a standby battery the test is to be conducted at 85 percent of the charged battery voltage. When the standby battery provides a trouble signal requiring replacement at higher than 85 percent of the charged battery voltage, the test is to be conducted at the battery trouble signal voltage level.

45.2.4 For operation at the reduced voltage, three alarms are to be energized from a source of supply in accordance with 42.1, following which the voltage is to be reduced to 85 percent of the test voltage specified in 42.1 for AC operated alarms, or the battery trouble level voltage for battery operated alarms, and then tested for signaling operation and sensitivity.

46 Temperature Test

46.1 The materials or components employed in an alarm shall not be subjected to a temperature rise greater than that indicated in Table 46.1, under any condition of operation.

Exception: When failure of a component results in an audible trouble signal resulting in the temperature rise of the component in the standby condition to exceed the limits in Table 46.1, in no case shall it be greater than the temperature permitted under an alarm condition.

Table 46.1
Maximum temperature rises

Device or material		Normal standby, °C	(°F)	Alarm condition, °C	(°F)
A. COMPONENTS					
1. Capacitors		25	(45)	40	(72)
2. Fuses		25	(45)	65	(117)
3. Rectifiers – At any point					
a. Germanium		25	(45)	50	(90)
b. Selenium		25	(45)	50	(90)
c. Silicon	(1) Maximum 60 percent of rated volts	50	(75)	75	(135)
	(2) 60 percent > rated volts	25	(45)	75	(135)
4. Relays and other coils with:					
a. Class 105 insulated windings					
Thermocouple method		25	(45)	65	(117)
Resistance method		35	(63)	75	(135)
b. Class 103 insulated windings					
Thermocouple method		45	(81)	85	(153)
Resistance method		55	(99)	95	(171)
5. Resistors[a]					
a. Carbon		25	(45)	50	(90)
b. Wire wound		50	(90)	125	(225)
c. Other		25	(45)	50	(90)
6. Sealing compounds		15°C (27°F) less than its melting point			
7. Solid state devices		See Note b			
B. INSULATED CONDUCTORS[c]					
1. Appliance wiring material		25°C (45°F) less than the temperature limit of the wire			
2. Flexible cord		35	(63)	35	(63)
C. ELECTRICAL INSULATION – GENERAL					
1. Fiber used as electrical insulation or cord bushings		25	(45)	65	(117)
2. Phenolic composition used as electric insulation or as parts where deterioration results in a risk of fire or electric shock		25	(45)	125	(225)
3. Varnished cloth		25	(45)	60	(108)
D. GENERAL					
1. Mounting surfaces		25	(45)	65	(117)
2. Wood or other combustible material		25	(45)	65	(117)

[a] When the temperature rise of a resistor other than a line voltage dropping resistor exceeds the value shown, the power dissipation shall be 50 percent or less of the resistor manufacturer's rating.

[b] The temperature of a solid state device (for example, transistor, SCR, integrated circuits), shall not exceed 50 percent of its rating during the Normal Standby Condition. The temperature of a solid state device shall not exceed 75 percent of its rated temperature under the Alarm Condition or any other condition of operation which produces the maximum temperature dissipation of its components. For reference purposes 0°C (32°F) is 0 percent. For integrated circuits the loading factor shall not exceed 50 percent of its rating under the Normal Standby Condition and 75 percent under any other condition of operation. Both solid state devices and integrated circuits are be operated up to the maximum ratings under any one of the following conditions:

1. The component complies with the requirements of MIL-STD 883C.
2. A quality control program is established by the manufacturer consisting of inspection and test of 100 percent of all components, either on an individual basis, as part of a subassembly, or equivalent.
3. Each assembled production unit is subjected to a burn-in test, under the condition which results in the maximum temperatures, for 24 hours while connected to a source of rated voltage and frequency in an ambient of at least 49°C (120°F) followed by a recalibration of the sensitivity and retested.

Table 46.1 Continued on Next Page

Table 46.1 Continued

Device or material	Normal standby,		Alarm condition,	
	°C	(°F)	°C	(°F)
[c] For standard insulated conductors other than those identified, reference shall be made to the National Electrical Code, ANSI/NFPA 70: the maximum temperature rise in any case is 25°C (45°F) less than the temperature limit of the wire in question.				

46.2 Except as noted in 46.3, all values for temperature rises apply to equipment intended for use in prevailing ambient temperatures, usually not higher than 25°C (77°F).

46.3 When equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25°C (77°F), the test of the equipment is to be made at the higher ambient temperature, and temperature rises specified in Table 46.1 are to be reduced by the amount of the difference between that higher ambient temperature and 25°C (77°F).

46.4 Temperature measurements on equipment intended for recessed mounting are to be made with the unit installed in an enclosure of nominal 3/4-inch (19.1-mm) wood having clearance of 2 inches (50.8 mm) on the top, sides and rear, and the front extended to be flush with the heat alarm cover.

46.5 A temperature is constant when three successive readings, taken at not less than 5 minute intervals, indicate no change.

46.6 Temperatures are to be measured by means of thermocouples consisting of wires not larger than AWG 24 (0.21 mm^2). The method of measuring the temperature of a coil shall be either the thermocouple or change-in-resistance method. The thermocouple method is not to be used for a temperature measurement at any point where supplementary thermal insulation is employed.

46.7 Thermocouples consisting of AWG 30 (0.06 mm^2) iron and constantan wires and a potentiometer-type indicating instrument are to be used whenever referee temperature measurements by thermocouples are required.

46.8 The thermocouple wire is to comply with the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

46.9 The temperature of a copper coil winding is determined by the change-in-resistance method by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the equation:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

in which:

T is the temperature to be determined in degrees C,

R is the resistance in ohms at the temperature to be determined,

r is the resistance in ohms at the known temperature,

t is the known temperature in degrees C.

46.10 As it is required to de-energize the winding before measuring R, it is appropriate for the value of R at shutdown to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time shall be plotted and extrapolated to give the value of R at shutdown.

46.11 To determine compliance with this test, an alarm is to be connected to a source of supply in accordance with 42.1 and operated under the following conditions:

a) Standby – 16 hours minimum. Constant temperatures

b) Alarm – 1 hour

c) Alarm – 7 hours or to battery depletion. Abnormal test.

46.12 When the temperature limits for 46.11(c) are exceeded there shall be no manifestation of a fire or approaching failure, and the alarm shall operate as intended following the test.

46.13 The alarm is to be subjected to the Dielectric Voltage-Withstand Test, Section 52, following 46.11 (b) or (c).

47 Transient Tests

47.1 General

47.1.1 An alarm shall operate for its intended signaling performance with its sensitivity not affected adversely when two representative samples are subjected to 500 supply line (high-voltage) transients, 500 internally induced transients, extraneous transients, and 60 supply line (low-voltage) circuit transients, while energized from a source of supply in accordance with 42.1 and connected to the device(s) intended to be used with the alarm.

47.1.2 Different alarms are to be used for each test. The alarms shall not false alarm for more than 1 second. Alarms using a primary battery as a power supply are to be subjected to the extraneous transients test only. When an alarm is intended for multiple-station connection, the transient tests are to be conducted with the maximum number of alarms intended to be connected.

47.1.3 Following the test the response of the units shall not show a time variation of more than 50 percent from the value obtained in the Oven Test, Section 26, on as-received samples.

47.2 Supply line (high-voltage) transients

47.2.1 For this test, the alarm is to be connected to a transient generator, consisting of a 2 kilovolt-amperes isolating power transformer and control equipment capable of producing the transients described in 47.2.2. See Figure 47.1. The output impedance of the transient generator is to be 50 ohms.

47.2.2 The transients produced are to be oscillatory and have an initial peak voltage of 6000 volts. The rise time is to be less than 1/2 microsecond. Successive peaks of the transients are to decay to a value of no more than 60 percent of the value of the preceding peak. Each transient is to have a total duration of 20 microseconds.

47.2.3 Each unit is to be subjected to 500 oscillatory transient pulses induced at a rate of once every 10 seconds. Each transient pulse is to be induced 90 degrees into the positive half of the 60 hertz cycle. A total of 250 pulses are to be applied so that the polarity of the transients is positive with reference to earth ground, and the remaining 250 pulses are to be negative with respect to earth ground.

47.3 Internally induced transients

47.3.1 The alarm is to be energized in the standby condition while connected to a source of supply in accordance with 42.1. The supply is to be interrupted for 1 second at a rate of not more than 6 cycles per minute for a total of 500 cycles. Following the test the alarm is operated for its intended signaling performance.

47.4 Extraneous transients

47.4.1 Single or multiple station heat alarms shall not false alarm and their intended operation shall not be impaired when subjected to extraneous transients generated by the devices and appliances described in 47.4.2. In addition, the alarm shall respond to heat during application of the transient condition.

47.4.2 Two single and two sets of multiple station heat alarms are to be energized from a source of rated voltage and frequency and subjected to transients generated from the following devices located 1 foot (305 mm) from the alarm, interconnecting wires, or both. The time of application for the condition specified in (a) is to be at least 2 minutes. The conditions specified in (c), (d), and (e) are to be applied for 10 cycles, each application of 2 seconds duration, except the last application shall be of a 10-minute duration. Near the end of the last cycle, an abnormal amount of heat is to be introduced onto the heat sensor to determine whether the unit is operational for heat with the transient applied.

a) Sequential arc (Jacob's ladder) generated between two 15 inch (381 mm) long, AWG 14 (2.1 mm^2) solid copper conductors attached rigidly in a vertical position to the output terminals of an oil burner ignition transformer or gas tube transformer rated 120 volts, 60 hertz primary; 10,000 volts, 60 hertz, 23 milliamperes secondary. The two wires are to be formed in a taper starting with an 1/8 inch (3.2 mm) separation at the bottom (adjacent to terminals) and extending to 1-1/4 inches (31.8 mm) at the top.

b) Energization and transmission of random voice message of five separate transmitter-receiver units (cellular phones) in turn, and operating in the following nominal frequencies:

1) 27 megahertz,

2) 150 megahertz,

3) 450 megahertz,

4) 866 megahertz, and

5) 910 megahertz.

A total of six energizations in each of two orientations are to be applied from each transmitter-receiver; five to consist of 5 seconds on and 5 seconds off, followed by one consisting of a single 15-second energization. For this test, the cellular phones are to be in the same room and on the same plane as the alarm under test. The cellular phones are to be positioned to generate a field strength of 20 volts/meter at the surface of the alarm's printed-wiring board. The test is to be conducted with the antenna tip pointed directly at the alarm, and at right angle to the first position centered on the alarm.

c) Energization of an electric drill rated 120 volts, 60 hertz, 2.5 amperes.

d) Energization of a soldering gun rated 120 volts, 60 hertz, 2.5 amperes.

e) Energization of a 6-inch (152-mm) diameter solenoid-type vibrating bell[a] with no arc suppression and rated 24 volts.

[a] Edwards, Model 439D-6AW, vibrating bell rated 0.075 amperes, 20/24 volts DC or equivalent.

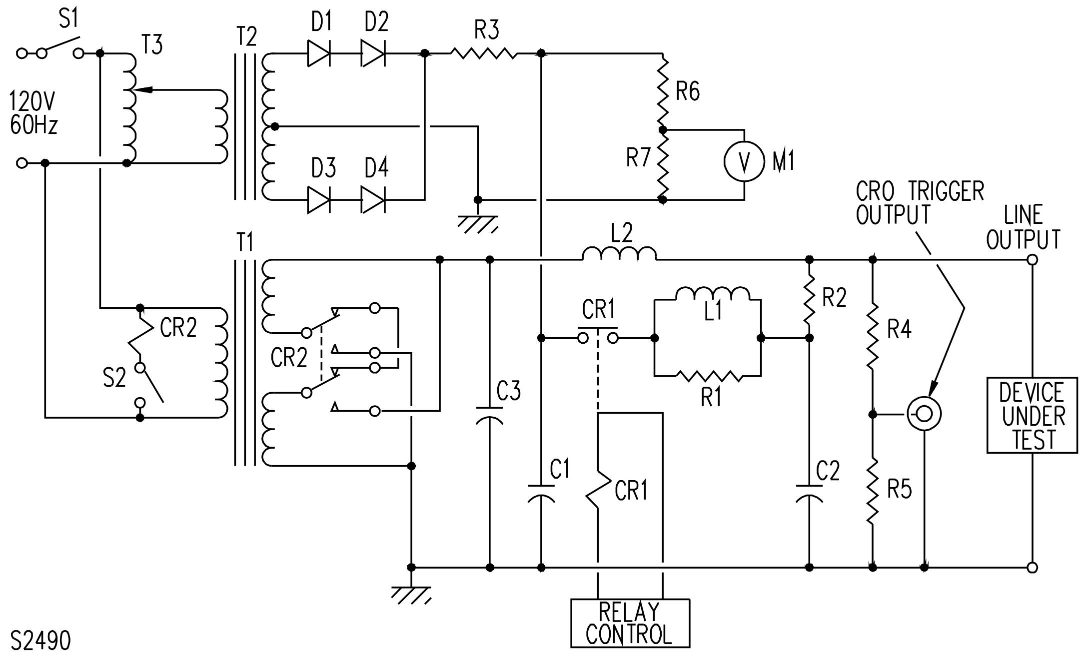
47.5 Supply line (low-voltage) circuit transients

47.5.1 Each of two low-voltage heat alarms is to be subjected to 60 transient voltage pulses. The pulses are to be induced into:

a) The heat alarm circuit intended to be connected to the low-voltage initiating device circuit of a system control unit and

b) The low-voltage power supply circuit of the alarm.

Figure 47.1
Surge generator circuit



C1	– Capacitor, 0.025 µF, 10 kV
C2	– Capacitor, 0.006 µF, 10 kV
C3	– Capacitor, 10 µF, 400 V
CR1	– Relay, coil 24 VDC. Contacts, 3-pole, single throw, each contact rated 25 A, 600 VAC maximum, all three poles wired in series.
CR2	– Relay, coil 120 VAC. Contacts DPDT. Provides either 120 V or 240 V test circuit.
D1	– D4 – Diodes, 25 kV PIV each
L1	– Inductor 15 µH [33 turns, AWG 22 wire, wound on 0.835 inch (21.2 mm) diameter PVC tubing]
L2	– Inductor, 70 µH [45 turns, AWG 14 wire, wound on 2.375 inch (60.33 mm) diameter PVC tubing]
M1	– Meter, 0 – 20 VDC
R1	– Resistor, 22 Ohms, 1 W, composition
R2	– Resistor, 12 Ohms, 1 W, composition
R3	– Resistor, 1.3 megohms, (12 in series, 110K ohms each, 1/2 W)
R4	– Resistor, 47K ohms (10 in series, 4.7K ohms each, 1/2 W)
R5	– Resistor, 470 ohms, 1/2 W
R6	– Resistor, 200 megohms, 2 W, 10 kV
R7	– Resistor, 0.2 megohms (2 in series, 100K ohms each, 2 W, carbon composition)
S1	– Switch, SPST
S2	– Switch, SPST, key-operated, 120 VAC, 1 A
T1	– Transformer, 2 kVA, 120 V primary, 1:1 (120 V or 240 V output)
T2	– Transformer, 90 VA, 120/15,000 V
T3	– Variable autotransformer, 2.5 A

47.5.2 For this test, each circuit is to be subjected to five different transient waveforms having peak voltage levels in the range of 100 to 2400 volts, as delivered into a 200 ohm load. A transient waveform at 2400 volts shall have a pulse rise time of 100 volts per microsecond, a pulse duration of 80 microseconds, and an energy level of 1.2 joules. Other applied transients shall have peak voltages representative of the entire range of 100 to 2400 volts, with pulse durations from 80 to 110 microseconds, and energy levels not less than 0.3 joule or greater than 1.2 joules.

47.5.3 The alarm is to be subjected to 60 transient pulses induced at the rate of six pulses per minute as follows:

a) Twenty pulses (two at each transient voltage level specified in 47.5.1) between each circuit lead or terminal and earth ground, consisting of ten pulses of one polarity, and ten of the opposite polarity (total of 40 pulses) and

b) Twenty pulses (two at each transient voltage level specified in 47.5.1) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten of the opposite polarity.

47.5.4 Following the test the response of the units shall not show a time variation of more than 50 percent from the value obtained in the Oven Test, Section 26, on as-received samples.

48 Static Discharge Test

48.1 The components of an alarm shall be shielded so that its operation is not adversely affected when subjected to static electric discharges. Operation of the trouble circuit during this test is not a failure when the subsequent operation of the alarm is not impaired. During the test a 5 second or less false alarm is permitted. The test is to be conducted in an ambient temperature of 23 ±3°C (73 ±5°F), at a relative humidity of 10 ±5 percent, and a barometric pressure of not less than 700 mm of mercury (194 kPa).

48.2 Each of two alarms is to be mounted in its intended mounting position and connected to a source of supply in accordance with 42.1. When an alarm is intended to be installed on a metal back box, the box is to be connected to earth ground. A 250 picofarad low leakage capacitor, rated 10,000 volts dc, is to be connected to two high-voltage insulated leads, 3 feet (0.9 m) long. A 1500 ohm resistor is to be inserted in series with one lead. The end of each lead is to be attached to a 1/2 inch (12.7 mm) diameter metal test probe with a spherical end mounted on an insulating rod. The capacitors are to be charged by touching the ends of the test leads to a source of 10,000 volts DC for at least 2 seconds for each discharge. One probe is to be touched to the alarm and the other probe is then to be touched to earth ground.

48.3 Ten discharges are to be applied to different points on the exposed surface of the alarm, recharging the capacitors for each discharge. Five discharges are to be made with one lead connected to earth ground and the other lead probed on the alarm surface followed by five discharges with the polarity reversed. For an alarm intended to be serviced by the consumer, ten additional discharges shall be applied as described above except each lead shall be probed, in turn, on all internal parts subject to contact by the user.

48.4 Following the test the response of the units shall not show a time variation of more than 50 percent from the value obtained in the Oven Test, Section 26, on as-received samples.