7.18 Polarity Reversal

7.18.1 An audible signaling device, intended to be connected to a specific polarity, shall operate for its intended signaling performance after being connected to each polarity of the supply source at the voltage indicated. The reversed polarity is to be applied for at least 1 h and then the audible signaling device is to be connected to a source of supply having the correct polarity.

7.18.2 Prior to and at the end of the test, the audible signaling device is to be subjected to Clause 7.3, Output Sound Pressure Level.

7.19 Electric Shock Current

7.19.1 Any part that is exposed only during operator servicing shall not present a risk of electric shock. A shock hazard from contact with a live part is considered to exist if the open circuit potential of the part to earth ground or any other exposed accessible part exceeds 42.4 V (peak) and the available current or stored energy exceeds the values specified in 7.19.2, 7.19.3, and 7.19.5.

7.19.2 The continuous current flow through a 500 Ω resistor connected between the part and earth ground or any other exposed accessible part shall not exceed the values specified in Table 10, Maximum Acceptable Continuous Current.

7.19.3 The duration of a transient current flowing through a 500 Ω resistor connected between the part and earth ground or other exposed accessible part shall not exceed the following:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

Where:

I = The peak current in milliamperes; and

T = The interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 mA and the time that the current falls below 7.1 mA for the last time; or

b) 809 mA, regardless of duration.

7.19.4 The interval between occurrences shall be equal to or greater than 60 s if the current is repetitive. Typical calculated values are shown in Table 11, Maximum Acceptable Transient Current Duration.

7.19.5 The maximum capacitance between the accessible terminals of the capacitor shall not exceed the values given by the following equations:

$$C = \frac{88\,400}{E^{1.43}(\text{Ln } E - 1.26)} \quad \text{for} \quad 42.4 \leq E \leq 400$$

or:

$$C = 35\,288\ E^{-1.5364} \text{ for } 400 \leq E \leq 1000$$

Where:

C = The maximum capacitance of the capacitor in microfarads, and

E = The potential in volts across the capacitor prior to discharge. E is to be measured 5 s after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like.

7.19.6 Typical calculated values of maximum capacitance are shown in Table 12, Electric Shock-Stored Energy.

7.19.7 With reference to the requirements of 7.19.2 and 7.19.3 the current is to be measured while the resistor is connected between ground and each accessible part individually, and all accessible parts collectively, if the parts are simultaneously accessible. The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

7.19.8 With reference to the requirements of 7.19.7, parts are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is considered to be able to contact parts simultaneously if the parts are within a 100 by 200 mm (4 by 8 in) rectangle; and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 1800 mm (71 in) apart.

7.19.9 Electric shock current refers to all currents, including capacitively coupled currents.

7.19.10 If the audible signaling device has a direct-current rating, measurements are to be made with the audible signaling device connected in turn to each side of a 3-wire, direct current supply circuit.

7.19.11 Current measurements are to be made with any operating control, or adjustable control that is subject to user operation, in all operating positions, and either with or without a plug-in device, separable connector, or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

7.19.12 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 MΩ, a minimum wattage rating of 1/2 W, and shall be effective with the power switch in either the on or off position.

Exception: The conductive connection is not required to be provided if such a connection is established in the event of electrical breakdown of the antenna isolating means, the breakdown does not result in a risk of electric shock and, in a construction employing an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 MΩ.

7.19.13 The maximum value of 5.2 MΩ specified in 7.19.12 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 MΩ with 20% tolerance or a resistor rated 4.7 MΩ with a 10% tolerance is acceptable. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements of CSA C22.2 No.1, Audio Video and Similar Electronic Equipment or the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384, may be rated a minimum of 1/4 W.

7.20 Tests on Polymeric (Plastic) Materials

7.20.1 General

7.20.1.1 Polymeric materials used for the sole support of current-carrying parts, or for all or part of an enclosure of an audible signaling device, shall be subjected to the tests in Temperature, 7.20.2, and Flame, 7.20.3 and 7.20.4. Where possible, a complete audible signaling device shall be used.

7.20.1.2 An audible signaling device moulded from polymeric material rated Flammability class 5VA in accordance with:

a) In Canada, CSA C22.2 No. 0.17, Evaluation of Polymeric Materials,

b) In the United States, the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

is considered to comply with the requirements of 7.20.3 and 7.20.4 without the necessity of further tests.

7.20.2 Accelerated Air-Oven Aging Test (Temperature)

7.20.2.1 There shall not be warping that impairs intended operation or exposes high-voltage uninsulated current carrying parts when representative samples of a polymeric material are aged as described in 7.20.2.2.

7.20.2.2 At least three representative samples shall be mounted on supports in an air circulating oven maintained at 90°C ±2ºC (194ºF) for 7 d or at 70ºC ±2ºC (158ºF) for 28 d. Following the aging period, the sample is to be inspected for distortion while still in the oven. The sample shall then be removed from the oven and permitted to cool to room temperature. Falling off of the sample's cover shall be permitted only when parts operating at a potential greater than 30 Vac or 42,4 Vdc are not exposed, operation is not affected, and the cover can be replaced as intended. Where the conditioning process has damaged electronic components, it is permissible to replace them.

7.20.2.3 The output sound pressure level shall not be reduced more than 3 dB from the output sound pressure level prior to the test above.

7.20.3 Flame Test – 19 mm (3/4 in)

7.20.3.1 When tested in accordance with 7.20.3.2 through 7.20.3.6, a polymeric (plastic) material employed as part of an audible signaling device rated 30 Vac (42.4 V DC or AC peak) or less and used for the sole support of current-carrying parts or as an enclosure shall not flame for more than 1 min after two 30 s applications of a test flame, with an interval of 1 min between applications of the flame. The sample shall not be completely consumed.

7.20.3.2 **(REV1)** Three samples of the equipment are to be conditioned by placing them in a forced draft circulating air oven maintained at a uniform temperature not less than 10 °C (18 °F) higher than the maximum temperature of the material measured under normal operating conditions, and not less than 70 °C (158 °F) in any case. The samples are to remain in the oven for 7 days. After cooling to room temperature for a minimum of 4 h, the samples are to be tested as described in 7.20.3.3 to 7.20.3.6.

Exception: Unconditioned test samples may be used when both of the following conditions are met:

a) The material does not exhibit a reduction in its flame-resistance properties as a result of long-term thermal aging; and

b) The thermal-aging program used for such determination included specimens having a thickness equal to or less than the wall thickness of the polymeric part.

7.20.3.3 **(REV1)** Three samples of the part are to be subjected to the Flame Test described in 7.20.3.5. In the performance of the test, the equipment is to be supported in its normal operating position in a draft free location. Nonpolymeric portions are not to be removed and insofar as possible, the internal mechanism of the equipment is to be in place. The flame is to be applied to an inside surface of the sample at a location judged as capable of becoming ignited because of its proximity to a source of ignition. Each sample is to be tested with the flame applied to a different location.

Exception: Unconditioned test samples may be used when both of the following conditions are met:

a) The material does not exhibit a reduction in its flame-resistance properties as a result of long-term thermal aging; and

b) The thermal-aging program used for such determination included specimens having a thickness equal to or less than the wall thickness of the polymeric part.

7.20.3.4 With reference to 7.20.3.3, the sections judged capable of becoming ignited are to be those adjacent to coil windings, splices, open-type switches, or arcing parts.

7.20.3.5 The flame of a Bunsen or Tirrill burner having a tube with a length of 9.5 ±0.3 mm (0.374 ±0.12 in) and an inside diameter of 100 ±10 mm (3.94 ±0.39 in) is to be adjusted to have a 19 mm (3/4 in) height of yellow flame with no blue cone. Two 30 second applications of the tip of the flame are to be made to each section of the equipment specified as indicated above, with 1 min intervals between the applications. A supply of technical-grade methane gas is to be used with a regulator and meter for uniform gas flow.

Exception: Natural gas having a heat content of 37 MJ/m^3 (1000 Btu/ft^3) at 23°C (73°F) has been found to provide similar results and is appropriate for use.

7.20.3.6 When one sample from a set of three does not comply with 7.20.3.1, an additional set of three samples shall be tested. All samples from the second set shall comply with 7.20.3.1.

7.20.4 Flame Test – 127 mm (5 in)

7.20.4.1 When tested in accordance with 7.20.4.2 through 7.20.4.6, a plastic material employed as part of an audible signaling device rated greater than 30 Vac (42.4 V DC or AC peak) and used for the sole support of current-carrying parts or as an enclosure all of the following results shall be obtained:

a) The material shall not continue to burn for more than 1 min after the fifth 5 s application of the test flame, with an interval of 5 s between applications of the flame;

b) Flaming drops or flaming or glowing particles that ignite surgical cotton 305 mm (12 in) below the test specimen shall not be emitted by the test sample at any time during the test; and

c) The material shall not be destroyed in the area of the test flame to such an extent that the integrity of the part is affected with regard to containment of fire or exposure of high voltage parts.

7.20.4.2 **(REV1)** Three samples of the complete equipment or three test specimens of the molded part shall be subjected to this test. Consideration is to be given to leaving in place components and other parts that influence the performance. The test samples are to be conditioned in a full draft circulating air oven for 7 days at 10°C (18°F) greater than the maximum use temperature and not less than 70°C (158°F) in any case. Prior to testing, the samples are to be conditioned for a minimum of 40 h at 23.0 ±2.0°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity. The flame is to be applied to an inside surface of the sample at a location judged as capable of becoming ignited because of its proximity to a source of ignition. When more than one part is near a source of ignition, each sample is to be tested with the flame applied to a different location.

Exception: Unconditioned test samples may be used when both of the following conditions are met:

a) The material does not exhibit a reduction in its flame-resistance properties as a result of long-term thermal aging; and

b) The thermal-aging program used for such determination included specimens having a thickness equal to or less than the wall thickness of the polymeric part.

7.20.4.3 The three samples shall perform as described in 7.20.4.1. When one sample does not comply, the test is to be repeated on a set of three new samples with the flame applied under the same conditions as for the unsuccessful sample. All the new specimens shall comply with 7.20.4.1.

7.20.4.4 The Bunsen or Tirrill burner with a tube length of 9.5 ±0.3 mm (0.374 ±0.12 in), and an inside diameter of 100 ±10 mm (3.94 ±0.39 in), is to be placed remote from the specimen, ignited, and adjusted so that when the burner flame is 127 mm (5 in), the height of the inner blue cone is 38 mm (1-1/2 in). The tube is not to be equipped with end attachments, such as stabilizers.

7.20.4.5 When a complete enclosure is used to conduct the flame test, the sample is to be mounted as intended in service, as long as it does not impair the flame testing, in a draft-free test chamber, enclosure, or laboratory hood. A layer of surgical cotton is to be located 305 mm (12 in) below the point of application of the test flame. The 127 mm (5 in) flame is to be applied to any portion of the interior of the part judged as capable of being ignited (by its proximity to live or arcing parts, coils, wiring, or other possible sources of ignition) at an angle of 20° from the vertical so that the tip of the blue cone touches the specimen. The test flame is to be applied to three different locations on each of the three samples tested. A supply of technical-grade methane gas is to be used with a regulator and meter for uniform gas flow.

Exception No. 1: The flame shall be applied to the outside of an enclosure when the equipment is of the encapsulated type, or of a size that prohibits the flame being applied inside.

Exception No. 2: Natural gas having a heat content of 37 MJ/m^3 (1000 Btu/ft^3) at 23°C (73°F) has been found to provide similar results and is appropriate for use.

7.20.4.6 The flame is to be applied for 5 s and removed for 5 s. The operation is to be repeated until the specimen has been subjected to five applications of the test flame.

7.21 Mechanical Strength Tests for Enclosures

7.21.1 An audible signaling device enclosure assembly, including a grille and/or exposed horn, as applicable, shall be of sufficient mechanical strength to withstand abuse anticipated in shipping, installation and service.

7.21.2 A sample shall be mounted in accordance with the installation instructions. A push force of 110 N shall be gradually applied and maintained for 1 min by means of a 12.7 mm (1/2 in) diameter steel hemisphere to the external surface most likely to impair the operation of the device or create a risk of fire or electric shock.

7.21.2.1 **(REV1)** When the audible signaling device is intended for indoor use, the impacts specified in 7.21.3 are to be conducted at room temperature. When the device is intended for outdoor use, the impacts are to be conducted after the units have been conditioned at minus 40°C (minus 40°F) for 3 hours.

7.21.3 A sample shall be mounted in accordance with the installation instructions and Figure 9, Mechanical Strength Tests for Enclosures.. Three impacts of 7 J (5 foot pounds) shall be applied by means of a solid, smooth, steel sphere 50 mm (2 in.) in diameter, with a mass of 540 g, (1.19 lbs.) The sphere shall either be dropped from a sufficient height (usually 1300 mm from the bottom of the ball to the surface to be impacted) or swung through a pendulum arc from a sufficient height to apply an impact force of 7 J of energy to the external surface most likely to impair the operation of the device, or create a risk of fire or electric shock.

Note: Unless specified, the same sample may be reused for each of the above applied forces. It is not prohibited to use a different sample for the application of each force in 7.21.2 and 7.21.3.

7.21.4 **(REV1)** As a result of the tests specified in 7.21.2 and 7.21.3, there shall be no exposure of live parts, impairment of the operation of the signaling device, or creation of a risk of electric shock.

7.21.5 A bending force created by a 3.0 m (118-7/64 in) minimum length of conduit of the intended size shall be installed:

a) In a hub or an opening if provided as part of the enclosure; or

b) If a hub or opening is not provided, in the center of the largest unreinforced surface intended for the connection of conduit.

7.21.6 The enclosure shall be securely mounted as intended in service, but positioned so that the installed conduit extends in a horizontal plane. The test shall be terminated once the deflection of the conduit end exceeds 255 mm (10 in). If a weight is necessary to cause the conduit end to deflect, the test shall be terminated once the deflection of the conduit end exceeds 255 mm (10 in) or once a bending moment of 33.9 N-m (300 lb-in) is achieved. The magnitude of the weight shall be determined from the equation:

$$W = (0.1\ M - 0.5\ CL) / L$$

In which:

W is the weight to be hung at the end of the conduit;

L is the length of the conduit from the wall of the enclosure to the point at which the weight is suspended;

C is the weight of the conduit; and

M is the bending moment required.

For the SI system of units:

W is measured in kilograms;

L is measured in meters;

C is measured in kilograms; and

and M is in Newton-meters.

For the inch-pound system of units:

W is measured in pounds;

L is measured in inches;

C is measured in pounds; and

M is in pound-inches.

7.21.7 Following the application of each force, the audible signaling device is to be examined for damage and energized from a source of rated voltage and frequency to check for intended operation. Cracking of the enclosure is permitted if it does not impair intended operation, but is not when a dust- or moisture-tight enclosure is used

7.21.8 There shall be no reduction in electrical spacings, no exposure of uninsulated energized parts at potential above 30 Vac (42.4 volts DC or AC peak), and no impairment of performance during and after the application of the forces and impacts of 7.21.2. The integrity of the conduit termination shall not be reduced as a consequence of the test of 7.21.2. Falling off of the sample's cover shall be permitted only when circuits operating at greater than 30 Vac (42.4 volts DC or AC peak) are not exposed, operation is not affected, and the cover can be replaced as intended. A dielectric withstand test of the sample shall be conducted in accordance with Clause 7.7, Dielectric Voltage-Withstand. The output sound pressure level shall not be reduced more than 3 dB from the output sound pressure level prior to the test above.

7.22 Interference from Radio Frequency and Electromagnetic Radiation

7.22.1 General

7.22.1.1 Prior to the tests specified below, the device is to be subjected to the test specified in Subsection 7.3, Output Sound Pressure Level

7.22.1.2 Audible signaling devices shall not be adversely affected and shall operate as intended after being subjected to the tests specified in:

a) Extraneous Radio Frequency Transients, 7.22.2;

b) Supply-Line Transients, 7.22.3;

c) Internally Induced Transients, 7.22.4; and

d) Signal-Line Transients, 7.22.5.

7.22.2 Extraneous Radio Frequency Transients

7.22.2.1 Audible signaling devices incorporating circuitry for functional interfacing with a control unit for purposes such as supervision, point addressing, multiplexing, etc., shall be capable of withstanding extraneous transients generated by the equipment described in 7.22.2.2 and 7.22.2.3 without:

a) Causing unintended operation,

b) Inhibiting intended operation,

c) Damaging any part; or

d) Adversely affecting its subsequent normal operation.

7.22.2.2 Two audible signaling devices shall be energized from a source of rated voltage and frequency and subjected to transients generated from transmitters located 300 mm (11.8 in) from the audible signaling device. The 300 mm distance is to be measured from the transmitter antenna to the nearest edge of the signaling device under test.

7.22.2.3 Five separate transmitter units shall be energized in turn, each having a 5 W output using random voice messages, and operating at the nominal frequencies (±2 %) of 27 MHz, 150 MHz, 450 MHz, 866 MHz, and 910 MHz. A total of six energizations are to be applied from each transmitter, five to consist of 5 s 'on' and 5 s 'off', followed by one consisting of a single 15 s energization. For this test, the transmitter is to be in the same room as the audible signaling device under test. The tests are to be performed with the:

a) Antenna tip pointed directly at the signaling device; and

b) Antenna at right angles to the direction (a) and centred on the signaling device. Refer to Figure 10, Extraneous Radio Frequency Transients.

7.22.3 Supply-Line Transients

7.22.3.1 An ac-operated audible signaling device rated at greater than 30 Vac shall operate as intended after being subjected to transients induced directly into the power supply circuit.

7.22.3.2 For this test, the audible signaling device is to be connected to a transient generator capable of producing the transients described in 7.22.3. The output impedance of the transient generator is to be 50 Ω.

7.22.3.3 The transients produced are to be oscillatory at 100 K Hz and are to have an initial peak voltage of 6000 V. The rise time is to be less than 0.5 μs. Successive peaks of the transient are to decay to a value of not more than 60 % of the value of the preceding peak.

7.22.3.4 The audible signaling device is to be subjected to 500 transient pulses induced at a rate of 6 transients per min. Each transient pulse is to be included 90º into the positive half of the 60 Hz 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.

7.22.4 Internally Induced Transients

7.22.4.1 The audible signaling device is to be energized while connected to a rated source of supply, which is to be interrupted for approximately 1 s at a rate of not more than 6 cycles/min for a total of 500 cycles.

7.22.5 Signal-Line Transients

7.22.5.1 Audible signaling devices rated at less than 30 Vac (42.4 V DC or AC peak) intended to be connected to Signal-line circuits of control units shall operate as intended after being subjected to transients induced into the audible signaling device.

7.22.5.2 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 V, as delivered into a 200 Ω load. A transient waveform at 2400 V shall have a pulse rise time of 100 V/μs, a pulse duration of approximately 80 μs, and an energy level of approximately 1.2 J (0.9 ft lbs). Other applied transients shall have peak voltages representative of the entire range of 100 to 2400 V, with pulse durations from 80 to 110 μs, and energy levels not less than 0.3 J (0.2 ft lbs) or greater than 1.2 J.

7.22.5.3 The audible signaling device 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 7.22.5.2) 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 7.22.5.2) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten of the opposite polarity.

7.22.5.4 Following the test in 7.22.5.3, the output sound pressure level shall not be reduced more than 3 dB from the sound output pressure level prior to the test.

7.23 Marking Permanence

7.23.1 General

7.23.1.1 Markings affixed to an audible signaling device shall be sufficiently durable as to resist the deleterious effects of handling, cleaning agents, and the like, expected in the intended use.

7.23.1.2 Markings considered to be permanent include:

a) Molded and die-stamped;

b) Stamped or etched metal that is permanently secured;

c) Indelibly-printed, pressure-sensitive labels secured by adhesive that, upon investigation, is rated for the type of surface and temperatures of the surface to which it is affixed and found to comply with:

1) In Canada, CSA C22.2 No. 0.15, Standard for Adhesive Labels;

2) In the United States, the Standard for Marking and Labeling Systems, UL 969; and