

**OTHER
RECOGNIZED
DOCUMENT**

ULC/ORD-C539-15

SINGLE AND MULTIPLE STATION HEAT ALARMS

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FOREWORD

Certification organizations are periodically requested to promptly provide certification services for devices, constructions, materials and systems where Canadian recognized Standards do not currently exist or are not entirely applicable. Accordingly, the certification organization utilizes its experience, existing specifications and requirements in related areas, together with assistance from its advisory councils to develop and prepare Other Recognized Documents (ORDs) for use in conducting the necessary tests and evaluation investigation.

Underwriters Laboratories of Canada has prepared many ORDs in response to requests from, and in conjunction with, industry, code writing bodies, regulatory agencies and others prior to promulgating a certification program. In many instances such documents have become published ULC Standards and subsequently National Standards of Canada. It is the intention of Underwriters Laboratories of Canada to continue this practice, as appropriate.

Comments on the content of this ORD should be directed to the Head Office of Underwriters Laboratories of Canada, 7 Underwriters Road, Toronto, Ontario, CANADA, M1R 3A9.

NOTE: These Other Recognized Documents are accepted under the National Standards System of Canada. Reference may be made to the Document CAN-P-3, "General Requirements for Bodies Operating Product Certification Systems"; and CAN-P-1500, "Additional Requirements for Accreditation of Certification Bodies", published by the Standards Council of Canada located at 270 Albert Street, Suite 200, Ottawa, Ontario, CANADA, K1P 6N7.

SINGLE AND MULTIPLE STATION HEAT ALARMS

PREFACE

This is the First Edition of the Other Recognized Document ULC/ORD-C539, Standard for Single and Multiple Station Heat Alarms.

Only metric SI units of measurement are used in this ORD. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

Appendix A and C, identified as normative, forms a mandatory part of this ORD.

Appendix B, identified as informative, is for informational purposes only.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Attention is drawn to the possibility that some of the elements of this ORD may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this ORD should be sent to the ULC Mark Program Owner of Underwriters Laboratories of Canada. The requests should be worded in such a manner as to permit a “yes” or “no” answer based on the literal text of the requirement concerned.

This ORD is intended to be used for conformity assessment.

ULC/ORD-C539-15

1 SCOPE

1.1 These requirements cover heat-actuated, single and multiple station heat alarms intended for indoor and unconditioned space installation as recommended in the end product installation instructions and in accordance with the following:

- a) National Building Code of Canada, and
- b) National Fire Code of Canada

1.2 These requirements do not cover electrically operated single or multiple station smoke alarms.

2 Reference Publications

2.1 The documents shown below are referenced in the text of this ORD. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard.

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

- ANSI/ASTM E230/E230M-12, Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- ASTM B117-11, Standard for Salt Spray (Fog) Testing

Documents Published by CSA Group
5060 Spectrum Way, Suite 100, Mississauga, Ontario L4W 5N6 Canada
Telephone: 1-800-463-6727, Fax: (416) 747-2473 www.csa.ca

- CSA C22.1-12, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations
- CSA C22.2 No. 17-00 (R2013), Standard for Evaluation of Properties of Polymeric Materials

Documents Published by the Department of Defense (DoD)
700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 U.S.A.
<http://assist.daps.dla.mil>

- MIL-HDBK-217F(2) – February 28, 1995 Reliability Prediction of Electronic Equipment
- MIL-STD-750E – January 3, 2012 Test Methods for Semiconductor Devices
- MIL-STD- 883B – February 26, 2010 Test Methods for Microcircuits

Documents Published by the International Electrotechnical Commission (IEC)
3, rue de Varembé
P.O. Box 131
1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11
www.iec.ch

- IEC 61000–4–5, Electromagnetic Compatibility (EMC) Part 4-5: Testing and Measurements Techniques – Surge Immunity Test

Documents Published by the Institute of Electrical and Electronics Engineers (IEEE)
3 Park Avenue, 17th Floor, New York, New York 10016-5997 U.S.A.
Telephone: (212) 419-7900
www.ieee.org

- ANSI/IEEE C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

Documents Published by the National Research Council Canada (NRCC)
1200 Montreal Road, Bldg. M-58, Ottawa, ON K1A 0R6 Canada
Telephone: (613) 993-9101 or 1-877-672-2672
www.nrc-cnrc.gc.ca

- National Building Code of Canada, 2010
- National Fire Code of Canada, 2010

3 GENERAL

3.1 Components

3.1.1 Except as indicated in 3.1.2, a component of a product covered by this ORD shall comply with the requirements for that component.

3.1.2 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 ORD, or
- b) Is superseded by a requirement in this ORD.

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

3.1.4 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.

3.1.5 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

4 GLOSSARY

4.1 For the purpose of this ORD, the following definitions apply.

4.2 **ALARM SIGNAL** – An audible signal transmitted throughout a zone or zones or throughout a building to advise occupants that a fire emergency exists.

4.3 **HEAT ALARM, SINGLE STATION** — A self-contained fire alarm device comprising of a heat alarm, an alarm sounding device, and a stored energy source (wound spring) incorporated in one integral package.

4.4 LIMITED LIFE COMPONENT – A component that is expected to fail and be periodically replaced and whose failure is supervised, when failure of the component affects the intended operation, heat sensitivity or both. Typical examples of such components include incandescent lamps, electronic tube heaters, functional heating elements, and batteries. See also 11.2.4

4.5 MECHANICALLY OPERATED HEAT ALARM — A heat alarm having a temperature sensitive bimetal or eutectic element and a spring-wound-type mechanism with clapper mounted within a bell housing. The snap action of the bimetal or melting of the eutectic element releases the spring mechanism resulting in a bell-type sound.

4.6 RELIABLE COMPONENT – A component that is not expected to fail or be periodically replaced and is not monitored. A reliable component shall have a predicted failure rate of 2.5 or less failures per million h as determined for a “Ground Fixed” (GF) environment by MIL-HDBK 217, or equivalent.

4.7 RISK OF ELECTRIC SHOCK — A risk of shock exists between any two uninsulated conductive parts or between an uninsulated conductive part and earth ground, if the continuous current flow through the circuit connected between the two points exceeds a 5 mA rms (7 mA peak) and if the open circuit voltage exceeds 30 V rms (42.4 V peak) or 60 V dc for dry and damp or 15 V rms (21.2 V peak) or 30 V dc for wet locations.

4.8 RISK OF FIRE — A risk of fire is determined to exist at any point in a circuit where:

- a) The open circuit voltage is more than 42.4 V peak, and the energy available to the circuit under any condition of load, including short circuit, results in a current of 8 A or more after 1 min of operation or
- b) A power of more than 15 W is deliverable into an external resistor connected between the two points.

4.9 TROUBLE SIGNAL — A visible or audible signal intended to indicate a fault or trouble condition.

4.10 UNCONDITIONED SPACES — Enclosed spaces without continuous climate controls where an individual spends time and where there is a potential for carbon monoxide buildup. (Examples include attached garages, crawl spaces and attics associated with a family living unit, cottages and cabins with combustible fuel appliances and/or fireplaces, barns, etc.)

4.11 VOLTAGE CLASSIFICATION — Unless otherwise indicated, all voltage and current values specified in this standard are rms:

- a) **Extra-Low-Voltage Circuit** - A circuit that has an AC voltage of not more than 30 V alternating current (AC) (42.4 volts peak) and maximum power of 100 VA, such as supplied by a Class 2 transformer; or a circuit of not more than 30 volts direct current (DC) supplied by a primary battery; or a circuit supplied by a combination of a transformer and fixed impedance, that as a unit, complies with all the performance requirements of a Class 2 transformer. A circuit that is derived from a supply circuit of more than 30 V by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not identified as an extra-low-voltage circuit.
- b) **Hazardous-Voltage Circuit** - A circuit having characteristics in excess of those of an extra-low-voltage circuit.

5 INSTALLATION AND OPERATING INSTRUCTIONS

5.1 A copy of the installation and operating instructions, and related schematic wiring diagrams and installation drawings shall be used as a reference in the examination and test of the alarm. For this purpose, a printed edition is not required. The information is to be included in a owner's manual.

5.2 The instructions and drawings shall include such directions and information as deemed by the manufacturer to be required for proper and safe installation, testing, maintenance, operation, and use of the alarm.

6 TEMPERATURE CLASSIFICATION

6.1 Single and multiple station heat alarms are classified as to their temperature of operation. See Table 1.

6.2 The maximum rating of a heat alarm shall not exceed 107°C (225°F).

7 ELECTRICALLY OPERATED ALARMS

7.1 Alarm Reliability Prediction

7.1.1 The maximum failure rate for electrically operated alarm units shall be 4.0 failures per million h as calculated by a full part stress analysis prediction as described in Section 2.0 of MIL-HDBK 217B, or 3.5 failures per million h as calculated by a simplified parts count reliability prediction as described in Section 3.0 of MIL-HDBK 217B, or equivalent. A "Ground Fixed" (GF) environment is to be used for all calculations. When actual equivalent data is available from the manufacturer, it shall be used in lieu of the projected data for the purpose of determining reliability.

7.1.2 Any component whose failure results in energization of an audible trouble signal, energization of a separate visual indication (orange or yellow), de-energization of a power-on light, or:

- a) Does not affect the normal operation or
- b) Is evaluated by specific performance tests included in this ORD does not require inclusion in the failure rate calculation. Examples include the audible signal appliance, thermostat, test switch, and battery contacts.

7.1.3 An integral or remote accessory, such as an integral transmitter or remote sounding appliance, is not required to be included in the reliability prediction except for those components whose failure affects the normal operation of the alarm.

7.1.4 A custom integrated circuit used in an alarm shall have a predicted failure rate of not greater than 2.5 failures per million hours. The failure rate is to be determined through evaluation of data in a 3000-hour burn-in test, or equivalent.

7.2 Battery Removal Indicator

7.2.1 Removal of a battery from a battery-operated (or AC with battery back-up) heat alarm shall result in a readily apparent and prominent visual indication. The visual indication shall consist of:

- a) A warning flag that is exposed with the battery removed and the cover closed;
- b) A hinged cover that is resistant to being closed with the battery removed or

c) An equivalent arrangement. (Such as an audible trouble signal on an AC with battery back-up).

7.2.2 Removal of a battery from a battery-operated (or AC with battery back-up) heat alarm that is intended to be removed from its mounting location for battery replacement, shall render the unit resistant to reinstallation.

7.2.3 When a warning flag, or equivalent, is employed to comply with the requirement of 7.2.1 or 7.2.2, it shall be marked as required in 13.1.2.

8 CONSTRUCTION REQUIREMENTS

8.1 Mechanically Operated Heat Alarm

8.1.1 Mounting

8.1.1.1 A heat alarm shall be provided with a means for mounting either to a ceiling or wall.

8.1.1.2 The means for mounting shall not result in any distortion of the heat alarm that alters its operating characteristics.

8.1.2 Calibration

8.1.2.1 Any means for calibration or adjustment shall be guarded or sealed to reduce the risk of manipulation by hand or ordinary tools. A thermal responsive element adjustment, if provided as part of a unit, shall not be adjustable after shipment from the factory.

8.1.2.2 A calibration means is considered not accessible or apparent when it is not showing, not exposed to manipulation by conventional tools, or not readily displaced. The complete concealment of conventional tool-engaging means to a screw, such as a slot, recessed head, and the like, by the use of solder or brazing material is considered to prevent manipulation if the calibration means cannot be changed by gripping with conventional tools, and engagement or manipulation is prevented at all other locations.

8.1.3 Materials

8.1.3.1 Diaphragms and spring parts shall be made of nonferrous material, such as phosphor bronze, nickel, silver, and the like or of ferrous materials. If ferrous materials are used, they shall be hermetically sealed or plated so as to protect against corrosion.

8.1.3.2 A heat sensing element, provided that it is used as the operating member of a heat alarm, shall be protected against conditions it is likely to be exposed to when in service, as represented by the tests described in Sections 9.1 – 13 of this ORD.

8.1.3.3 All exposed parts whose required performance can be impaired by corrosion shall be protected by enameling, galvanizing, sherardizing, plating, or other means determined to be equivalent.

8.1.4 Operating Mechanisms

8.1.4.1 The moving parts of a heat alarm shall have sufficient play at bearing surfaces to protect against binding.

8.1.4.2 A gear train driving spring shall be securely anchored at each end. The spring winding means shall be provided with a positive stop to limit the winding or shall withstand the maximum force likely to be applied without impairing the operation of the mechanism.

8.1.5 Mechanical Assembly

8.1.5.1 Any servicing or restoration operations intended to be made by the user shall be simple and capable of being accomplished with ordinary hand tools.

8.1.5.2 An alarm shall be so constructed that parts will not become displaced during or after installation.

8.1.5.3 An obstruction means, such as a wire mesh screen, shall be provided to protect against the entry of foreign bodies or materials into sounding devices that could prevent their operation. The maximum size of the openings shall be 3.2 mm (1/8 in). The obstruction means is to be attached securely in place. See the Vibration Test, Section 9.1.8.

8.1.6 Power Supervisory Feature

8.1.6.1 A means shall be provided on a unit to automatically indicate that operating power is not available. The indication may be in the form of a flag, target, sight glass, change in mounting position of the heat alarm, or other means determined to be equivalent.

8.2 Electrically Operated

8.2.1 Accessories

8.2.1.1 Unless specifically indicated otherwise, the construction requirements specified for an alarm shall apply also for any remote accessories with which it is to be employed

8.2.2 Supplementary Signaling Features

8.2.2.1 A supplementary signaling feature, such as a transmitter for remote signaling, included integral with a single or multiple station heat alarm, is to be compatible with the device(s) with which it is intended to be employed, and the remote signaling device(s) shall be intended for fire alarm application.

8.2.3 Servicing and Maintenance Protection

8.2.3.1 General

8.2.3.1.1 An uninsulated live part of a high-voltage circuit within the enclosure shall be located, guarded, or enclosed so as to minimize accidental contact by persons performing service functions suitably performed with the equipment energized.

8.2.3.1.2 An electrical component which requires examination, replacement, adjustment, servicing, or maintenance with the alarm energized shall be located and mounted with respect to other components and with respect to grounded metal so that it is accessible for such service without subjecting the user to an electric shock from adjacent uninsulated high-voltage live parts.

8.2.3.1.3 The following are not identified as uninsulated live parts:

- a) Coils of relays, solenoids, and transformer windings, when the coils and windings are provided with insulating overwraps capable of being used for this purpose;
- b) Terminals and splices with insulation rated for the intended application and
- c) Insulated wire.

8.2.3.2 Sharp Edges

8.2.3.2.1 An edge, or corner of an enclosure, opening, frame, guard, knob, handle, or other similar projection of a heat alarm shall be smooth and rounded, so as not to result in a cut-type injury when contacted during use or user maintenance.

8.2.4 Enclosure

8.2.4.1 General

8.2.4.1.1 The enclosure of a heat alarm shall be sufficiently strong and rigid to resist the abuses likely to be encountered in normal service. The degree of resistance to abuse inherent in the heat alarm shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects, which alone or in combination constitute an increase in the fire shock, and/or accident hazards.

8.2.4.1.2 Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be evaluated in determining compliance with the requirement of 8.2.4.1.1.

8.2.4.1.3 All electrical parts of a heat alarm, including a separate power supply, except for plug-in blades, shall be enclosed to provide protection against contact with uninsulated live parts. A separate enclosure for field-wiring terminals to be enclosed by a back box is not required.

8.2.4.1.4 The enclosure of a heat alarm shall be provided with means for mounting in the intended manner. Any fittings, such as brackets or hangers, required for mounting means shall be accessible without disassembling any operating part of the alarm. The removal of a completely assembled panel or cover to mount the alarm is not identified as disassembly of an operating part.

8.2.4.1.5 If the heat alarm is intended for permanent connection, the enclosure shall either have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable, or have provision for mounting on an outlet box.

8.2.4.2 Cast Metal Enclosures

8.2.4.2.1 The thickness of cast metal for an enclosure shall be as indicated in Table 2. When cast metal having a thickness 0.8 mm (1/32 in) less than that indicated in Table 2 is employed, the surface under consideration is to be curved, ribbed, or otherwise reinforced, or the shape of the surface, size of the surface, or both, are such that equivalent mechanical strength is provided.

8.2.4.2.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, there shall not be less than 3.5 threads nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing is capable of being properly attached.

8.2.4.2.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall not be less than 3.5 full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

8.2.4.3 Sheet Metal Enclosures

8.2.4.3.1 The thickness of sheet metal used for the enclosure of a heat alarm shall not be less than that indicated in Table 3, except that sheet metal of two gage sizes lesser thickness shall be employed only when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape of the surface, the size of the surface, or both, are such that equivalent mechanical strength is determined to be provided..

8.2.4.3.2 At any point where conduit or metal clad cable is to be attached, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have a stiffness at least equivalent to that of an uncoated, flat, sheet steel having a minimum thickness of 1.6 mm (1/16 in).

8.2.4.3.3 A ferrous plate or plug closure for an unused conduit opening or other hole in the enclosure shall have a thickness not less than 0.69 mm (0.027 in) or 0.81 mm (0.032 in) nonferrous metal for a hole having a 35 mm (1-3/8 in) diameter maximum dimension.

8.2.4.3.4 A closure for a hole larger than 35 mm (1-3/8 in) diameter shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

8.2.4.3.5 A knockout in a sheet metal enclosure shall be secured and shall be capable of being removed without excessive deformation of the enclosure.

8.2.4.3.6 A knockout shall be provided with a surrounding surface for seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout used during installation does not result in spacings between uninsulated live parts and the bushing of less than those indicated in Spacings, Section 8.2.14.

8.2.4.4 Nonmetallic Enclosures

8.2.4.4.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be formed so that operating parts are protected against damage. The mechanical strength of the enclosure shall be at least equivalent to a sheet metal enclosure of the minimum thickness specified in Table 3. See also the Tests of Thermoplastic Materials, Section 11.12.

8.2.4.4.2 The continuity of any grounding system to which an alarm is to be connected shall not rely on the dimensional integrity of the nonmetallic material.

8.2.4.4.3 Polymeric materials used for an enclosure shall comply with the following requirements:

- a) Enclosures containing parts including a risk of fire - minimum flammability rating of V-0 and compliance with the Flame Test 127 mm (5 in) as described in 11.12.3.1 – 11.12.3.6.
- b) Enclosures containing Class 2 circuits with a voltage not exceeding 30 volts AC, 42.4 volts-peak, or 60 volts DC - minimum flammability rating of:
 - i) V-2 or;
 - ii) HB and successful completion of the 19 mm (3/4 in) Flame test, Section 11.12.2; and
- c) Enclosures containing circuits powered by sources with energy limited to 15 W - minimum flammability rating of HB.

8.2.5 Ventilating Openings

8.2.5.1 Ventilating openings in an enclosure for high-voltage circuits including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or perforated covers, shall be of such size or shape that no opening permits passage of a rod having a diameter of 3.6 mm (9/64 in). An enclosure for a fuse(s) or other overload protective device provided with ventilating openings shall afford protection against the emission of flame or molten metal. Openings used to clean internal parts, shall be constructed to prevent damage to functional internal components during such cleaning operations.

8.2.5.2 Perforated sheet metal and sheet metal employed for expanded metal mesh shall be not less than 1.0 mm (0.042 in) in average thickness, 1.2 mm (0.046 in) when zinc coated.

8.2.5.3 When the indentation of the guard enclosure does not alter the clearance between uninsulated live parts and grounded metal so as to reduce spacings below the minimum values required, it is permissible for 0.5 mm (0.021 in) expanded metal mesh or perforated sheet metal, 0.6 mm (0.024 in) when zinc coated, to be employed under the following conditions:

- a) The exposed mesh on any one side or surface of the product has an area of not more than 465 cm² (72 sq. in) and has no dimension greater than 305 mm (12 in) or
- b) The width of an opening so protected is not greater than 88.9 mm (3-1/2 in).

8.2.5.4 The wires forming a screen protecting high-voltage current-carrying parts shall not be smaller than 1.3 mm² (AWG 16) and the screen openings shall not be greater than 3.2 cm² (1/2 square in) in area.

8.2.6 Covers

8.2.6.1 An enclosure cover, other than the type usually employed over the sensing chamber, shall be hinged, sliding, pivoted, or similarly attached when:

- a) It provides ready access to fuses or any other overcurrent protective device, the intended protective functioning of which requires renewal or
- b) It is required that the cover be opened periodically in connection with the intended operation of the alarm.

For the purpose of this requirement, intended operation is identified as operation of a switch for testing or for silencing an audible signal device or operation of any other component of a heat alarm that requires such action in connection with its intended performance.

Exception: This requirement does not apply to heat alarms where the lamp is intended to be periodically replaced, or to the battery replacement aspect of a heat alarm employing a battery as the main or standby supply

8.2.6.2 A cover that is intended to be removed only for periodic cleaning of the sensing chamber shall be secured by any one of the following or equivalent means: positive snap catch, plug-in or twist action, snap tab with one screw, or two or more screws.

8.2.6.3 When an alarm cover is not intended to be removed for cleaning, maintenance, or both, and the alarm is intended to be returned to the factory for servicing, the cover shall be secured so that it is not readily removed. Exposed screw slots or nuts, other than a tamper-proof type, shall be sealed or covered. See 14.1.1 (bb) for supplementary marking.

Exception: These requirements do not apply when the alarm cover is intended to be removed for cleaning, maintenance, or both, even though the alarm is intended to be returned to the manufacturer for servicing.

8.2.6.4 A hinged cover is not required where the only fuse(s) enclosed is intended to provide protection to portions of internal circuits, such as employed on a separate printed-wiring board or circuit subassembly, to prevent circuit damage resulting from a fault. The use of such a fuse(s) shall occur only when the word "CAUTION" «MISE EN GARDE» and the following or equivalent marking is located on the cover of a alarm employing high-voltage circuits: "Circuit Fuse(s) Inside - Disconnect Power Prior To Servicing" «Circuit fusible (s) à l'intérieur– Débranchez l'alimentation pour effectuer une réparation.»

8.2.6.5 A hinged cover shall be provided with a latch, screw, or catch to hold it closed. An unhinged cover shall be securely held in place by screws or the equivalent.

8.2.7 Glass Panels

8.2.7.1 Glass covering an enclosure opening shall be held securely in place so that it is not capable of being displaced in service and shall provide mechanical protection of the enclosed parts. The thickness of a glass cover shall not be less than that indicated in Table 4.

8.2.7.2 A transparent material other than glass employed as a cover over an opening in an enclosure shall have mechanical strength equivalent to that of glass, shall not become a fire hazard or distort, and shall not become less transparent at the temperature to which it may be subjected under normal or abnormal service conditions.

8.2.7.3 A lens, light filter, or similar part of a heat alarm shall be constructed of a material the transparency of which is not impaired by the conditions to which it is exposed in service as represented by the performance tests described in the Performance Tests, Sections 9.1 – 11.19.

8.2.8 Corrosion Protection

8.2.8.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

8.2.8.2 The requirement of 8.2.4.1 applies to all sheet steel or cast iron enclosures, and to all springs and other parts upon which mechanical operation depends. It does not apply to minor parts, such as washers, screws, bolts, and other parts, when the failure of such unprotected parts does not result in a risk of fire or electric shock or injury to persons or impair the operation of the alarm. Parts made of stainless steel, polished or treated when required, do not require additional protection. Bearing surfaces shall be of materials that prevent binding due to corrosion.

8.2.9.3 Metal shall not be used in combinations such as to result in galvanic action which adversely affects cabinets or enclosures.

8.2.9.4 Hinges and other attachments shall be resistant to corrosion.

8.2.9.5 Nonferrous cabinets and enclosures may be employed without special corrosion protection.

8.2.9 Power Supply

8.2.9.1 Primary Power Supply

8.2.9.1.1 The primary power supply of a single station heat alarm shall be either a utility supply (commercial light and power source) or an integral battery or batteries. Connection to the utility supply (commercial light and power source), when used, shall be in the form of permanent wiring to terminals or leads in a separate wiring compartment having provision for the connection of conduit, metal-clad or nonmetallic sheathed cable, by means of a power-supply cord and attachment-plug, or by means of a separate power supply.

8.2.9.1.2 If a separate power supply is provided, it shall have limited output energy consisting of an open circuit voltage not in excess of 30 V rms, 42.4 V peak or direct current (dc), and its output capacity shall be limited to a maximum of 100 VA. The energy may be limited by an energy limiting device having an output rating of 100 VA or less or by a transformer plus additional circuitry having characteristics equivalent to those of a 100 VA transformer.

8.2.9.2 Secondary Power Supply

8.2.9.2.1 A secondary power supply, such as a battery, shall be provided and have the capacity to supply the maximum intended power to the heat alarm for no less than 7 days in the standby condition and thereafter be able to operate the heat alarm for an alarm signal for at least 4 min continuously. This capacity shall be measured using a fully charged battery or other applicable rechargeable energy storage media, or a fresh non-rechargeable battery, as appropriate.

8.2.9.2.2 If a battery or set of batteries is employed as the main source of power of a heat alarm, it shall meet the requirements of the Battery Tests, Section 11.17.

8.2.9.2.3 When a battery is used for the secondary power supply, it shall be of either a rechargeable or non-rechargeable type. For a rechargeable type battery, the maximum charging current, as well as the maximum trickle charging current available, shall not exceed the battery manufacturer's specifications. For a non-rechargeable type battery, data on battery life, including discharge curves, shall be provided for the investigation to evaluate battery shelf aging and performance characteristics.

8.2.9.2.4 The discharge condition of a non-rechargeable or rechargeable type battery shall be monitored where a trouble indication is obtained. The monitoring shall take place whether the alarm is operating on the primary supply or on the standby supply.

8.2.10 Batteries

8.2.10.1 General

8.2.10.1.1 When a battery or set of batteries is used as the main source of power of a single or multiple station heat alarm, it shall comply to the requirements of the Battery Tests, Section 11.17.

8.2.10.1.2 When a non-rechargeable or rechargeable type battery is used as a secondary power supply, the marking on the unit shall include specified periodic battery replacement instructions.

8.2.10.1.3 Batteries included as part of an alarm shall be so located and mounted that terminals of cells are prevented from coming in contact with uninsulated live parts, terminals or adjacent cells, or metal parts of the enclosure as a result of shifting.

8.2.10.1.4 A battery compartment intended for use with rechargeable batteries which emit gases during charging shall be provided with vent holes.

8.2.10.1.5 Ready access shall be available to the battery compartment to facilitate battery replacement, without damage to the alarm components or disassembly of any part of the alarm, except for a cover or the equivalent.

8.2.10.1.6 Connections of external wiring to a battery-operated single- or multiple-station heat alarm, or to a portable accessory, shall not be subjected to stress or motion during battery replacement, servicing, or both. Removal of the alarm or accessory from the mounting support to replace a battery or to service the unit shall occur only when the connected wiring is not subjected to flexing or stress.

8.2.10.2 Battery Connections

8.2.10.2.1 Lead or terminal connections to batteries shall be identified with the proper polarity, (plus or minus signs), and provided with strain relief. It is not prohibited for the polarity to be indicated on the unit adjacent to the battery terminals or leads.

8.2.10.2.2 Connections to battery terminals shall be either by a lead terminating in a positive snap action type of clip, or a fixed butt type connection which applies a minimum of 6.6 N (1.5 lbs) force to each battery contact, or equivalent. The connection shall consist of an unplated or plated metal which is resistant to the corrosive action of the electrolyte.

8.2.10.2.3 Each lead of a clip-lead assembly used as part of a battery operated alarm shall be a minimum of 0.32 mm² (22 AWG) stranded wire with a minimum 0.4 mm (1/64 in) insulation.

8.2.10.3 Supplementary Signaling Circuits

8.2.10.3.1 For a cord-connected or battery operated single station alarm employing a supplementary signaling circuit which is energized from a separate source of supply, the source of energy shall not exceed the energy limits defined in Power Supply Tests, Section 11.18.

8.2.10.3.2 For an alarm intended to be connected to a fixed wiring system and employing a separately energized signaling circuit, the source of energy shall not exceed the limits in Power Supply Tests, Section 11.18.

8.2.11 Field-Wiring

8.2.11.1 Permanent Connection

8.2.11.1.1 General

8.2.11.1.1.1 A single station or multiple station heat alarm intended for permanent connection shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the C22.1-12, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, corresponding to the rating of the unit.

8.2.11.2 Field-Wiring Compartment

8.2.11.2.1 The field-wiring compartment area is to be sized for completing all field-wiring connections as specified by the installation wiring diagram. There shall be space within the compartment to permit the use of a standard conduit bushing on conduit connected to the compartment when a bushing is required for installation.

8.2.11.2.2 Protection for internal components and wire insulation from sharp edges shall be provided by insulating barriers or metal barriers having smooth rounded edges, or by protection that has been determined to be the equivalent.

8.2.11.3 Field-Wiring Terminals

8.2.11.3.1 Terminal parts to which field connections are to be made shall consist of binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position. Other terminal connections when provided shall be found to be equivalent.

8.2.11.3.2 When a wiring-binding screw is employed at a field-wiring terminal, the screw shall not be smaller than a 4.2 mm diameter (8 AWG).

8.2.11.3.3 Except as noted in 8.2.11.3.4, a terminal plate tapped for a wire-binding screw shall be of metal not less than 0.76 mm (0.030 in) thick and shall not have less than two full threads in the metal.

8.2.11.3.4 It is not prohibited for a terminal plate to have the metal extruded at the tapped hole for the binding screw so as to provide two full threads. Other constructions, when employed, shall provide equivalent security.

8.2.11.4 Field-Wiring Leads

8.2.11.4.1 Power supply leads provided for field connection shall not be less than 152 mm (6 in) long; shall be provided with strain relief; and shall not be smaller than 0.82 mm² (AWG 18). The insulation, when of rubber or thermoplastic, shall not be less than 0.8 mm (1/32 in) thick.

8.2.11.4.2 Leads provided for field connection to power limited fire protective signaling circuits, such as employed for multiple station interconnection or for connection to remote signaling devices, shall not be smaller than 1.3 mm² (AWG 16) for a single conductor, 0.65 mm² (AWG 19) for two or more conductors, and 0.32 mm² (AWG 22) for four or more conductors of a multi-conductor cable. The conductor shall be solid, bunch tinned stranded, or stranded copper. Stranded copper wire, consisting of not more than seven strands, shall be used only for 0.82 mm² (AWG 18) and larger conductors.

8.2.11.5 Grounded Supply Terminals and Leads

8.2.11.5.1 A field-wiring terminal for the connection of a grounded circuit conductor shall be identified by means of a metallic plated coating substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of the terminal for the connection of the grounded circuit conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

8.2.11.5.2 A field-wiring lead provided for connection of a grounded circuit conductor shall be finished to show a white or natural gray color and shall be readily distinguishable from other leads. No other leads, other than grounded conductors, shall be so identified.

8.2.11.5.3 A terminal or lead identified for the connection of the grounded circuit conductor shall not be electrically connected to a single-pole manual switching device that has an OFF position or to a single-pole overcurrent (not thermal) protective device.

8.2.11.6 Power Supply Cord

8.2.11.6.1 A cord-connected single station heat alarm shall be provided with not less than 1.83 m (6 ft) nor more than 6.10 m (20 ft) of flexible cord and a two or three prong attachment plug of the type and rating for connection to the supply circuit.

8.2.11.6.2 The flexible cord shall be of Type SPT-3, SV, SVT, SJ, SJT, or equivalent, minimum 0.82 mm² (AWG 18). It shall be rated for use at the voltage and ampacity rating of the alarm, in accordance with the C22.1-12, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

8.2.11.6.3 Means shall be provided to prevent the flexible cord from being pushed into the enclosure through the cord-entry hole when it is possible for such displacement to:

- a) Subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated,
- b) Reduce spacings below the minimum required values or
- c) Result in damage in internal components.

8.2.11.6.4 A smoothly rounded restraining means shall be provided for securing the attachment plug to the receptacle. The means shall withstand for 1 min a pull of 22 N (5 lbf) while installed as intended in service without any evidence of damage to the connection.

8.2.11.7 Equipment Bonding

8.2.11.7.1 General

8.2.11.7.1.1 An equipment bonding terminal or lead, or equivalent, is required for a hazardous-voltage alarm provided with an overall nonmetallic enclosure and cover that:

- a) Is intended to be serviced internally and
- b) Employs internal dead metal parts that become energized under a fault condition.

8.2.11.7.1.2 An equipment bonding terminal or lead is not required for:

- a) An extra-low-voltage alarm;
- b) A hazardous-voltage alarm provided with an overall nonmetallic enclosure and cover, and that is not intended to be internally serviced or
- c) A hazardous-voltage alarm provided with an overall nonmetallic enclosure and cover, where internal dead metal parts are not capable of either being energized under a fault condition nor being contacted during servicing.

8.2.11.7.2 Permanently Connected Units

8.2.11.7.2.1 The surface of an insulated lead intended solely for the connection of an equipment bonding conductor shall be green, with or without one or more yellow stripes. No other leads visible to the installer, other than bonding conductors, shall be so identified. A field-wiring terminal intended for connection of an equipment bonding conductor shall be plainly identified, such as being marked "G," "GR," "Ground," "Grounding," or the equivalent, or by a marking on a wiring diagram provided on the alarm. The field-wiring terminal shall be located so that it shall not be removed during servicing of the alarm.

8.2.11.7.3 Cord Connected Units

8.2.11.7.3.1 The bonding means for a cord-connected alarm, having an overall nonmetallic enclosure and cover, that is intended to be serviced internally shall consist of a separate bonding lead integral with the supply cord and terminating in the grounding pin of a parallel blade attachment-plug cap.

8.2.11.8 Remote Power Supply

8.2.11.8.1 For an alarm that is intended to be connected to a separate remote power supply such as a transformer, the supply cord is not required to be factory wired to the alarm, or to the transformer terminals or leads, when the installation instructions provided with the unit are explicit regarding the method of connection. The minimum size conductors between the alarm and remote power supply shall not be less than 0.82 mm² (18 AWG) and shall not be longer than 20 feet (6.1 m). The interconnecting wiring is to be provided with the alarm and the transformer by the manufacturer.

8.2.11.8.2 Where longer runs of interconnecting wiring are used in an installation, such as in a multiple station configuration, or where several alarms are supplied by a common power supply, the wiring is not required to be provided by the manufacturer. In addition, the resistance of the interconnecting wiring shall be a maximum of 10 Ω , unless otherwise specified by the manufacturer.

8.2.12 Internal Wiring

8.2.12.1 General

8.2.12.1.1 The internal wiring of an alarm shall consist of conductors having insulation rated for the potential involved and the temperatures to which it is subjected, and shall have the mechanical strength and current-carrying capacity for the service. The wiring shall be routed away from moving parts and sharp projections and held in place with clamps, string, ties, or equivalent, unless of rigidity that retains a shaped form.

8.2.12.1.2 Leads, or a cable assembly, connected to parts mounted on a hinged cover shall be of a length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to prevent abrasion of insulation and jamming between parts of the enclosure.

8.2.12.1.3 When the use of a short length of insulated conductor is not possible, such as for a short coil lead, electrical insulating tubing shall be employed. The tubing shall not be subjected to sharp bends, tension, compression, or repeated flexing, and shall not contact sharp edges, projections, or corners. The wall thickness of the tubing shall comply to the requirements for such tubing, except that the wall thickness at any point for polyvinyl chloride tubing of 9.5 mm (3/8 in) diameter or less, shall not be less than 0.43 mm (0.017 in). For insulating tubing of other types the wall thickness shall not be less than that required to at least equal the mechanical strength, dielectric properties, and heat and moisture resistance characteristics of polyvinyl chloride tubing having a wall thickness of 0.43 mm (0.017 in).

8.2.12.1.4 Internal wiring of circuits operating at different potentials shall be separated by barriers or shall be segregated, unless the conductors of the circuits of lower voltage are provided with insulation equivalent to that required for the highest voltage involved. Segregation of insulated conductors shall be accomplished by clamping, routing, or equivalent means that provides permanent separation.

8.2.12.1.5 Stranded conductors clamped under wire-binding screws, or similar parts, shall have the individual strands soldered together or be equivalently arranged, to provide reliable connections.

8.2.12.1.6 Wireways shall be smooth and free from sharp edges, burrs, fins, and moving parts to avoid the possibility of abrasion of the conductor insulation.

8.2.12.1.7 All splices and connections shall be mechanically secured to preclude shorting to adjacent uninsulated current carrying parts in the event that an improper connection, such as a cold solder joint, is made.

8.2.12.1.8 A splice shall be provided with insulation equivalent to that of the wires involved, when permanence of electrical spacing between the splice and uninsulated metal parts is not assured.

8.2.12.1.9 Splices shall be located, enclosed, and supported so that flexing, movement, or vibration shall not damage the insulation or affect the integrity of the splice.

8.2.12.1.10 A metal barrier shall have a thickness at least equal to that required by Table 2, as determined by the size of the barrier. A barrier of insulating material shall not be less than 0.71 mm (0.028 in) thick and shall be thicker when its deformation is readily accomplished so as to defeat its purpose. Any clearance between the edge of a barrier and a compartment wall shall not exceed 1.6 mm (1/16 in).

8.2.12.2 Bonding for Grounding

8.2.12.2.1 An exposed dead metal part of a hazardous-voltage alarm that becomes energized shall be bonded to the point of connection of the field-equipment bonding terminal or lead, when provided or required, and to the metal surrounding the knockout, hole, or bushing provided for field power-supply connections.

8.2.12.2.2 Uninsulated metal parts of electrical enclosures, transformer cores, mounting brackets, capacitors, and other electrical components are to be bonded for grounding when there is a possibility that they be contacted by the user or by a serviceman servicing or operating the equipment.

8.2.12.2.3 Metal parts as described below are not required to comply with the requirement of 8.2.12.2.2.

- a) Adhesive attached metal foil markings, screws, handles, or similar items that are located on the outside of the alarm enclosure and isolated from electrical components or wiring by grounded metal parts so that they do not become energized.
- b) Isolated metal parts, such as small assembly screws, that are positively separated from wiring and uninsulated live parts.
- c) Panels and covers that do not enclose uninsulated live parts, when wiring is positively separated from the panel or cover so that it does not become energized.
- d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 0.8 mm (1/32 in) thick and secured in place.

8.2.12.2.4 A bonding conductor shall be of material capable of being used as an electrical conductor. When of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent. The conductor shall not be smaller than the maximum size wire employed in the circuit wiring of the component or part. A separate bonding conductor or strap shall be installed in such a manner that it is protected from mechanical damage.

8.2.12.2.5 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, brazing, or welding or soldering of a mechanically secured component. The bonding connection shall penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not rely on the clamping action of rubber or similar material.

8.2.12.2.6 A bolted or screwed connection, that incorporates a star washer under the screwhead, is capable of being used for penetrating nonconductive coatings.

8.2.12.2.7 When the bonding means relies upon screw threads, two or more screws, or two full threads of a single screw, engaging metal is appropriate for use.

8.2.12.2.8 Metal-to-metal hinge-bearing members for doors or covers shall not be used as a means for bonding the door or cover for grounding unless a multiple bearing-pin type hinge is employed.

8.2.12.2.9 Splices shall not be employed in conductors used to bond electrical enclosures or components.

8.2.13 Electrical Components

8.2.13.1 General

8.2.13.1.1 Mounting of Components

8.2.13.1.1.1 A switch, lampholder, attachment-plug receptacle, plug connector, or similar electrical component, and uninsulated live parts shall be mounted securely and shall be prevented from turning.

Exception No. 1: It is not required that a switch be prevented from turning when all four of the following conditions are met:

- a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is determined to be subject to forces that tend to turn the switch during operation of the switch.*
- b) The means for mounting the switch shall be such that the operation of the switch loosens it.*
- c) The spacings are not reduced below the minimum required values when the switch rotates.*
- d) The operation of the switch is by mechanical means rather than by direct contact by persons.*

Exception No. 2: It is not required that a lampholder of the type in which the lamp is not capable of being replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel be prevented from turning when rotation does not reduce spacings below the minimum values required. See Spacings, Section 8.2.14.

8.2.13.1.1.2 Uninsulated live parts shall be secured to the base or mounting surface so that they are prevented from turning or shifting in position, where such motion results in the possibility of a reduction of spacings. Friction between surfaces shall not be relied upon as a means to prevent shifting or turning of live parts. A properly applied lock washer is accepted.

8.2.13.1.1.3 Uninsulated live parts, for example, field-wiring terminals, shall be secured to their supporting surfaces by methods other than friction between surfaces so that they are prevented from turning or shifting in position when such motion results in reduction of spacings below the minimum values required. This shall be accomplished by two screws or rivets; by square shoulders or mortises; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by an equivalent method.

8.2.13.1.2 Operating Components

8.2.13.1.2.1 Operating components and assemblies, such as switches, relays, and similar devices, shall be protected by individual dust covers or dust tight cabinets, against the possibility of impaired operation due to dust or other material.

8.2.13.1.2.2 Adjusting screws and similar adjustable parts shall be prevented from loosening under the conditions of actual use. The use of a properly applied lock washer to prevent loosening is accepted.

8.2.13.1.3 Current-Carrying Parts

8.2.13.1.3.1 A current-carrying part shall be of metal such as silver, copper or copper alloy, or equivalent material.

8.2.13.1.3.2 Bearings, hinges, and other similar parts are not to be used for carrying current between fixed and moving parts.

8.2.13.1.4 Electrical Insulating Material

8.2.13.1.4.1 Material for the mounting of current-carrying parts shall be porcelain, phenolic composition, cold-molded composition, or equivalent material.

8.2.13.1.4.2 When vulcanized fiber is used for insulating bushings, washers, separators, and barriers it shall not be as the sole support for uninsulated current-carrying parts of other than extra-low-voltage circuits.

8.2.13.1.4.3 Polymeric materials shall not be used for the sole support of uninsulated live parts unless found to be equivalent to the materials indicated in 8.2.13.1.4.1.

8.2.13.1.4.4 The thickness of a flat sheet of insulating material, such as phenolic composition employed for panel-mounting of parts, shall not be less than 1.6 mm (1/16 in) thick. Material less than 1.6 mm (1/16 in) thick shall not be employed unless the panel is supported or reinforced to provide equivalent rigidity.

8.2.13.1.4.5 A terminal block mounted on a metal surface capable of being grounded shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base unless the parts are staked, upset, sealed, or equivalently prevented from loosening so as to prevent the parts and the ends of replaceable terminal screws from coming in contact with the supporting surface or reducing spacings below the minimum values required.

8.2.13.1.4.6 A countersunk sealed part shall be covered with a waterproof insulating compound which shall not melt at a temperature 15 °C (27 °F) higher than the maximum normal operating temperature of the assembly, and not less than 65 °C (149 °F) in any case. The depth or thickness of the sealing compound shall not be less than 3.2 mm (1/8 in).

8.2.13.2 Bushings

8.2.13.2.1 When a lead or wire harness passes through an opening in a wall, barrier, or enclosing case, there shall be a metal or insulating type bushing, or the equivalent, which shall be substantial, secured in place, and have a smooth rounded surface against which the wire rests.

8.2.13.2.2 When the opening is in a phenolic composition or other nonconducting material, or in metal of thickness greater than 1.07 mm (0.042 in), a smooth surface having rounded edges is determined to be the equivalent of a bushing.

8.2.13.2.3 Ceramic materials and some molded compositions are capable of being used for insulating bushings, separate bushings of wood and hot-molded shellac shall not be used.

8.2.13.2.4 Fibre shall be employed only where:

- a) It is not subjected to a temperature higher than 90 °C (194 °F) under normal operating conditions;

- b) The bushing is not less than 1.6 mm (1/16 in) thick, with a minus tolerance of 0.4 mm (1/64 in) for manufacturing variations; and
- c) It is not affected adversely by normal ambient humidity conditions.

8.2.13.2.5 When a soft-rubber bushing or similar material that deteriorates with age is employed in a hole in metal, the hole shall be free from sharp edges, burrs, or similar projections, which cut into the bushing and wire insulation.

8.2.13.2.6 When an insulating metal grommet is used in lieu of an insulating bushing, the insulating material used shall not be less than 0.8 mm (1/32 in) thick and shall fill completely the space between the grommet and the metal in which it is mounted.

8.2.13.3 Lampholders and Lamps

8.2.13.3.1 A single station heat alarm intended to be connected to a commercial alternating current (AC) power source shall be provided with a "power-on" lamp to indicate energization of the unit. When pulsed, the lamp shall pulse at least once per minute.

8.2.13.3.2 Where more than one lamp is provided on the alarm, the "power-on" lamp shall be white or green, an alarm indicating lamp shall be red, and a trouble lamp shall be amber or yellow. When the "power-on" lamp is of a different color it shall be marked to identify the function.

8.2.13.3.3 A lampholder and lamp shall be rated for the circuit in which they are employed.

8.2.13.3.4 A lampholder in a hazardous-voltage circuit shall be wired so that the screw shell is connected to an identified (grounded circuit) conductor.

8.2.13.3.5 A lampholder shall be installed so that uninsulated hazardous-voltage live parts are not exposed to contact by persons removing or replacing lamps in service.

8.2.13.3.6 A lamp or equivalent means, such as a distinctive audible signal indication, shall be provided on an alarm intended for multiple-station interconnection to identify the unit from which the alarm was initiated.

8.2.13.4 Protective Devices

8.2.13.4.1 Fuseholders, fuses, and circuit breakers shall be rated for the application.

8.2.13.5 Printed-Wiring Boards

8.2.13.5.1 The components of a printed-wiring board shall be secured in place and the spacings between circuits shall comply with the spacings requirements for rigidly clamped assemblies (Table 5). The board shall be mounted so that deflection of the board during servicing shall not result in damage to the board or risk of fire or electric shock.

8.2.13.6 Switches

8.2.13.6.1 A switch shall have a current and voltage rating not less than that of the circuit which it controls.

8.2.13.6.2 When a reset switch is provided, it shall be of a self-restoring type.

8.2.13.6.3 An alarm silencing switch or equivalent means shall be provided if its off-normal position results in an audible alarm trouble signal, or if following alarm silencing the unit automatically returns to normal condition after a timed interval.

8.2.13.7 Transformers and Coils

8.2.13.7.1 A transformer shall be of the two-coil or insulated type.

Exception: An autotransformer shall only be employed in an alarm intended for permanent connection only, when the terminal or lead connected to the autotransformer winding which is common to both input and output circuits is identified, and the output circuits are located within the enclosure containing the autotransformer.

8.2.13.7.2 The insulation of coil windings of relays, transformers and similar components shall be such as to resist the absorption of moisture.

8.2.13.7.3 Film-coated or equivalently insulated wire is not required to be given additional treatment to prevent moisture absorption.

8.2.13.8 Dropping Resistors

8.2.13.8.1 A carbon composition resistor shall not be used as a dropping resistor in the hazardous-voltage circuit of an alarm.

8.2.14 Spacings

8.2.14.1 Spacings shall be maintained between uninsulated live parts and dead metal parts, and between uninsulated live parts of opposite polarity. The spacings shall not be less than those indicated in Table 5.

8.2.14.2 The spacings between an uninsulated live part and:

- a) A wall or cover of a metal enclosure;
- b) A fitting for conduit or metal-clad cable and
- c)) Any dead metal part.

8.2.14.3 The "Through-Air" and "Over-Surface" spacings of Table 5 measured at an individual component part are to be judged on the basis of the volt-amperes used and controlled by the individual component. However, the spacings from one component to another, and from any component to the enclosure or to other uninsulated dead metal parts, excluding the component mounting surface, shall be judged on the basis of the maximum voltage and total volt-amperes rating of all components in the enclosure.

8.2.14.4 The spacing requirements in Table 5 do not apply to the inherent spacings inside motors, except at wiring terminals, nor to the inherent spacings of a component provided as part of the alarm. Such spacings are judged on the basis of the requirements for the component. The electrical clearance resulting from the assembly of a component into the complete device, including clearances to dead metal or enclosures, shall be those indicated in Table 5.

8.2.14.5 The "To Wall of Enclosure" spacings of Table 5 are not to be applied to an individual enclosure of a component part within an outer enclosure.

8.2.14.6 Enameled or equivalently insulated wire is an uninsulated live part. Enamel is capable of being used as turn-to-turn insulation in coils.

8.2.14.7 Spacings on printed-wiring boards which are less than those indicated in Table 5 shall comply with the minimum spacings of Table 6 and shall be provided with a coating in compliance with Conformal Coatings on Printed-Wiring Boards, Section 11.19.

8.2.14.8 Spacings shall be maintained between uninsulated live parts and dead metal parts, and between uninsulated live parts of opposite polarity. The spacings shall not be less than those indicated in Table 5.

9 PERFORMANCE

9.1 All Alarms

9.1.1 General

9.1.1.1 Representative samples of units in commercial form shall be subjected to the tests specified in Sections 9.1.3 – 11.19.

9.1.1.2 If a heat alarm(s) is required to be mounted in a definite position in order to function as intended it shall be tested in that position.

9.1.1.3 If a heat alarm is intended to be connected to tubing to function, it shall be connected to the maximum length of tubing specified by the manufacturer unless the length of tubing would not have a bearing on its operation.

9.1.2 Determination of Spacings

9.1.2.1 The sensitivity of a heat alarm is to be expressed in terms of spacing limitations. Spacing limitations refer to the maximum distance permitted between devices mounted on smooth ceilings.

9.1.2.2 Installation spacing limitations of a heat alarm are to be determined by the Fire Test, Section 9.1.4.

9.1.2.3 Heat alarms used to determine installation spacing limitations shall be units classified for the highest ordinary temperature ratings in accordance with 5.1. The minimum fire test spacing allocation shall be 15.2 m (50 ft). Spacing allocation for the intermediate degree temperature classification is based on tests conducted on the highest ordinary degree rating.

9.1.2.4 A heat alarm does not comply with these requirements if it fails to qualify for at least a 15.2 m (50 ft) spacing, for example, if it does not operate within 2 min when subjected to the Fire Test, Section 9.1.4.

9.1.3 Oven Test

9.1.3.1 Five heat alarms must independently produce an alarm signal within 2 minutes or less, when subjected to the time-temperature condition shown by Figure 1 is eligible for a 4.57 m (15 ft) installation spacing. Heat detector samples shall be uniform in operation when mounted in the same position. They shall be tested in each of the different positions permitted by the design. Operation is considered uniform if the heat detectors operate within the applicable temperature range indicated in the tabulation under the Operating Temperature Test, Section 9.1.7.

9.1.3.2 Performance under this time-temperature condition is to be tested, recorded and compared to Figure 1 to determine the responsiveness of the device, its uniformity, and its qualifications for a 4.57 m (15 ft) spacing. The spacing limitation is to be based upon the performance with the samples located in the least favorable position on the sample-mounting panel.

9.1.3.3 To verify uniform performance of a heat alarm, the test is to be repeated four times (totaling 5 samples) using a different sample for each test, but each of the five samples is to be installed on the sample-mounting panel in the same position. Depending upon the construction of the heat alarm, it may be necessary to repeat the oven tests with test samples rotated 90° and 180° from the original test position.

9.1.3.4 The testing oven is to consist of an oval stainless steel container approximately 787 mm (31 in) long and 254 mm (10 in) wide by 406 mm (16 in) high, made of material with a minimum thickness of 2.74 mm (0.108 in). One of the curved end sections is to be hinged. See Figure 2.

9.1.3.5 A section 152 by 152 mm (6 by 6 in) at the top is to be fitted with a removable wooden cover. The heat alarms to be tested are mounted one at a time on this cover.

9.1.3.6 Two glass windows, 102 by 152 mm (4 by 6 in) in size, are to be provided in the sides of the oven for observation of the samples under test.

9.1.3.7 The interior of the oven is to be divided horizontally by a baffle over the heater chamber located in the central lower section. One end of the horizontal baffle is to be joined to a guide vane extending upward at an angle of 72° into the oven chamber. The vane is to direct the air currents to ensure greater uniformity of temperature in the oven.

9.1.3.8 Eight 1000 W cone-shaped heating coils threaded into screw shell lampholders are to furnish the heat. They are to be connected so that six of the heating coils are controlled by means of a data acquisition and control instrument. The other two heating coils are for supplying additional heat when necessary.

9.1.3.9 An air current through the bank of heaters is to be created by means of a four-blade 127 mm (5 in) fan located behind the heating coils and connected to a shaft that extends to the outside of the oven. A variable-speed motor is to be mounted on a bracket inside the lower cabinet and is to operate the fan through a pulley and belt arrangement. The speed of the motor is to be adjusted and the pitch of the fan blades is to be such that the velocity of the air current is 1.17 - 1.24 m/s (230 - 245 ft/min) over the sample under test.

9.1.3.10 Temperatures are to be measured by means of a type J thermocouple inserted through a tube extending to the inside of the test chamber, located in the same plane as the device under test, on the upstream side. The air velocity is to be measured prior to testing by a velometer inserted in the oven at a point approximately 31.8 mm (1-1/4 in) from the top of the oven in the same location as the heat alarm. The velocity is to be measured with the detector removed.

9.1.3.11 The time and temperature build-up during the test is to be monitored and controlled by a data acquisition and control instrument.

9.1.3.12 In certain devices, variations in operation are possible with the device installed in different positions with respect to the direction of air flow. In such cases, the sensitivity or spacing designation is to be determined from test data with the device mounted in the least favorable position.

9.1.3.13 Preparation for test consists of mounting the heat alarm on the small removable wooden panel. Conduit-fitting mountings are to be accommodated on a special panel provided with a 76.2 by 76.2 mm (3 by 3 in) conduit box fitted into the panel. Flush-mounted devices employ a plain wood panel. The test sample is to remain in the oven at least 5 min prior to the start of each test run.

9.1.3.14 Where applicable, multiple-station interconnect, relay connections or other wire connections are to be wired in accordance with the installation instructions. Operation of the alarms and their associated connections shall be verified in accordance with the requirements outlined in this ORD and the provided installation instructions.

9.1.3.15 After installation in the oven, the heat alarm is to be subjected to the time-temperature condition illustrated in Figure 1, Oven temperature at the start of the test is to be 29.4 °C – 32.2 °C (85 °F – 90 °F).

9.1.3.16 After the heat alarm produces the alarm signal, the current applied to the bank of heaters is to be cut off and the oven is to be cooled to room temperature by use of the external cooling fan.

9.1.4 Fire Test

9.1.4.1 To qualify for an installation spacing by fire tests, four highest ordinary-degree rated and four highest low-degree rated heat alarms are to be installed in the least favorable position as determined from the Oven Test, Section 9.1.3, and at the intended spacing, shall operate within 130 s. The temperature profile of the fire is to be monitored by a type J thermocouple located at the 3.05 m (10 ft) spacing, 178 mm (7 in) below the ceiling, and on the same diagonal as the alarm. The temperature profile shall be within the limits shown in Figure 3. At least two trials are to be conducted.

9.1.4.2 Fire tests are to be conducted in a 18.3 by 18.3 m (60 by 60 ft) test room with a smooth ceiling at a height of 4.80 m (15 ft, 9 in). The heat alarms are to be installed at their designated spacings, minimum 15.2 m (50 ft), in line with the sprinkler and fire test pan. See Figure 4 for the layout.

9.1.4.3 The fire tests are to be produced by burning denatured alcohol consisting of 190 proof ethanol to which 5 % methanol has been added as a denaturant in steel pans of a size necessary to produce a temperature rise within the limits shown in Figure 3. Since temperature conditions in a test room may vary throughout the year, it is necessary to use different pan sizes in order to obtain the intended temperature-rise condition. This test condition develops a time-temperature curve similar to the 4.57 m (15 ft) spacing curve shown by Figure 1.

9.1.4.4 The fire tests are to be conducted to develop information regarding the operating time of the heat alarms when installed at their recommended spacing schedule as compared with the operating time of automatic sprinklers installed on a standard 3.05 by 3.05 m (10 by 10 ft) spacing schedule. Operation of the heat alarms within 130 s will qualify the device for the spacing which it was installed.

9.1.4.5 Units that are intended to be mounted on a side wall are to be mounted in a vertical position so that the distance between the top of the unit and the ceiling is 305 mm (12 in). The distance between the top of the unit and the ceiling may be less than 305 mm (12 in) but not less than 102 mm (4 in) to the top of the alarm if the manufacturer's installation instructions specify a shorter distance. The front of the units shall face the fire source and the surface on which a unit is mounted shall extend 76 mm (3 in) beyond the periphery of the unit.

9.1.4.6 If a heat alarm is intended to be mounted on the ceiling, the unit is to be so installed for this test.

9.1.4.7 If a heat alarm is intended to be used with an enclosure such as used in mounting, it is to be subjected to the Fire Test, Section 9.1.4, using the enclosure representative for installation as intended.

9.1.5 High Temperature Exposure Test

9.1.5.1 Two heat alarms shall not produce an alarm or trouble signal and the fusible element of a nonrestorable heat alarm type shall not shift beyond the defined temperature classification when subjected to high temperature exposure tests for 30 days. The minimum temperature differential between the heat alarm rating and the test temperature is to be 5.6 °C (10 °F) for the low rating range, and 8.3 °C (15 °F) for the ordinary and intermediate ranges for the high rating range and above. See Table 7.

9.1.5.2 The heat alarms shall withstand the high temperature exposure and operate as intended when subjected to the Operating Temperature Test, Section 9.1.7, the Rate-of-Rise Operation Test, Section 9.1.11, or the Oven Test, Section 9.1.3, whichever is applicable.

9.1.5.3 Two sample heat alarms of each temperature rating are to be tested for their intended operating temperature (if capable of repeated operation), or rate-of-rise temperature, after which they are to be placed in an oven maintained at the temperature specified in 8.2.14.1. Connections are to be made as described in 8.2.12.1.5 between the devices and a power source, and means are to be provided for indicating operation of each of the devices under test.

9.1.5.4 The sample heat alarms are to be removed from the oven after the 30 day period and allowed to remain at room temperature for 24 h before being tested for a shift beyond the defined temperature classification while subjected to the Oven Test, Section 9.1.3, the Operating Temperature Test, Section 9.1.7, or the Rate-of-Rise Operation Test, Section 9.1.11, whichever is applicable. The average response obtained shall not be greater than 50 % of the value recorded on as-received samples.

9.1.6 Corrosion Tests

9.1.6.1 General

9.1.6.1.1 The sensitivity of fixed-temperature heat alarms, after they are subjected to corrosive atmospheres, shall not show a time variation of more than 50 % from the value obtained in the Oven Test, Section 9.1.3 on as-received samples. No false alarm or operation shall occur following the exposure. The sensitivity of heat alarm operating on the rate-of-rise principle, after they are subjected to corrosive atmospheres, shall not show a variation of more than 50 % from the value obtained in the Rate-of-Rise Operation Test, Section 9.1.11, on as-received samples. No false operation shall occur following the exposure to the corrosive atmospheres or at a temperature rise of 6.7 °C (12 °F) per min or less until a temperature of at least 54 °C (130 °F) is reached [starting from a temperature of 29.4 °C to 32.2 °C (85 °F to 90 °F)].

9.1.6.1.2 Samples of heat alarm capable of repeated operation are to be tested first for sensitivity as specified in the Oven Test, Section 9.1.3, before the corrosion tests. Samples of heat alarms not capable of repeated operation are not to be tested for sensitivity before the corrosion tests. Heat alarms operating on the rate-of-rise principle are to be subjected to the Rate-of-Rise Operation Test, Section 9.1.11, before and after exposure to the corrosive atmospheres.

9.1.6.1.3 Two samples are to be exposed to each applicable test atmosphere for 10 days.

9.1.6.1.4 After exposure to the corrosive atmosphere, the samples are to be removed from the test apparatus and allowed to remain at room temperature for at least 24 h, following which they are to be checked for sensitivity as specified in 9.1.6.1.1.