



UL 521

STANDARD FOR SAFETY

Heat Detectors for Fire Protective Signaling Systems

UL Standard for Safety for Heat Detectors for Fire Protective Signaling Systems, UL 521

Eighth Edition, Dated December 11, 2024

Summary of Topics

This Eighth Edition of UL 521 dated December 11, 2024 has been issued to incorporate changes from proposals dated January 19, 2024, May 10, 2024, and July 12, 2024.

The new requirements are substantially in accordance with Proposal(s) on this subject dated January 19, 2024, May 10, 2024, and July 12, 2024.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of ULSE Inc. (ULSE).

ULSE provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will ULSE be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if ULSE or an authorized ULSE representative has been advised of the possibility of such damage. In no event shall ULSE's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold ULSE harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

No Text on This Page



ULC Standards
Normes ULC

ULC Standards
CAN/ULC 530:2024
Second Edition



ULSE Inc.
ANSI/UL 521
Eighth Edition

Standard for Heat Detectors for Fire Protective Signaling Systems

December 11, 2024

Commitment for Amendments

This Standard is issued jointly by ULSE Inc. (ULSE) and ULC Standards. Amendments to this Standard will be made only after processing according to the Standards writing procedures by ULSE and ULC Standards.

ISSN 0317-526X © 2024 ULC Standards

All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, whatsoever without the prior permission of the publisher.

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

© 2024 ULSE Inc. All rights reserved.

Our Standards for Safety are copyrighted by ULSE Inc. Neither a printed nor electronic copy of a Standard should be altered in any way. All of our Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of ULSE Inc.

This ANSI/UL Standard for Safety consists of the Eighth Edition. The most recent designation of ANSI/UL 521 as an American National Standard (ANSI) occurred on December 11, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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

For information on ULSE Standards, visit <https://www.shopulstandards.com>, call toll free 1-888-853-3503 or email us at ClientService@shopULStandards.com.

CONTENTS

Preface	7
---------------	---

INTRODUCTION

1 Scope	9
2 Components	9
3 Units of Measurement	10
4 Referenced Publications	10
5 Glossary	11
6 Manufacturers Published Instructions	13
7 Compatibility Information	13
7.1 General	13
7.2 Method of evaluation	14
7.3 Changes affecting compatibility	14
8 Temperature Designation	14

ASSEMBLY

9 Mounting	15
10 Servicing and Maintenance Protection	15

CONSTRUCTION

11 General	16
12 Materials	16
13 Corrosion Protection	17
14 Enclosures	17
14.1 General	17
14.2 Cast metal enclosures	17
14.3 Sheet metal enclosures	18
14.4 Nonmetallic enclosures	19
14.5 Ventilating openings	19
14.6 Covers	20
14.7 Glass panels	21
15 Field-Wiring Connections	21
15.1 General	21
15.2 Field-wiring compartment	21
15.3 Field-wiring terminals	22
15.4 Special field-wiring connections (qualified application)	23
15.5 Field wiring leads	24
15.6 Special field-wiring terminals	24
15.7 Grounding terminals and leads	24
15.8 Grounded supply terminals and leads	25
15.9 Isolated (nongrounded) detectors	25
16 Strain Relief	27

MECHANICALLY OPERATED HEAT DETECTORS

17 Operating Mechanisms	27
18 Mechanical Assembly	27
19 Power Supervisory Feature	27

ELECTRICALLY OPERATED HEAT DETECTORS

20	Accessories	28
21	Supplementary Signaling Features	28
22	Internal Wiring.....	28
	22.1 General.....	28
	22.2 Bonding for grounding	29
23	Electrical Components.....	30
	23.1 General.....	30
	23.2 Bushings.....	31
	23.3 Visual indicators and lamps	32
	23.4 Protective devices	32
	23.5 Printed-wiring boards	32
	23.6 Switches	33
	23.7 Transformers and coils	33
	23.8 Dropping resistors	33
24	Spacings	33
	24.1 General.....	33
	24.2 Determination of heat detector installation spacings	36

PERFORMANCE

25	General	36
26	Heat Detector Guards	36
27	Normal Operation Test.....	36
	27.1 General.....	36
	27.2 Standardized alarm signal	37
28	Current-carrying parts	37
29	Contacts	38
30	Test Units and Data	38
	30.1 General.....	38
	30.2 Component reliability data	38
	30.3 Miscellaneous data	39
31	Test Voltages	39
32	Test Samples	39
33	Sensitivity-Spacing Allocation.....	40
34	Electrical Supervision Test	41
35	Oven Test	42
36	Fire Test	44
37	Rate-of-Rise Operation Test.....	46
38	High-Temperature Exposure Test	46
39	Corrosion Tests	47
	39.1 General.....	47
	39.2 Indoor-use heat detectors.....	48
	39.3 Outdoor-use heat detectors	48
40	Alternate Indoor Corrosion Test (21-Day)	49
41	Determination of Stress Cracking Test	49
	41.1 General.....	49
	41.2 Ammonia stress cracking test	49
	41.3 Salt immersion cycling test	49
42	Bond Secureness Test.....	50
43	Operating Temperature Test.....	50
44	Vibration Test	51
45	Humidity Test	51
46	Low Temperature Exposure Test	51
47	Survivability Test (For Units with Integral Sounder)	51



48	Audibility Test (For Detectors with Integral Sounders).....	52
48.1	General.....	52
48.2	Sound output measurement	52
48.3	Low frequency alarm signal format.....	53
48.4	Alarm sounder duration test.....	53
49	Jarring Test.....	53
50	Effect of Shipping and Storage	54
51	Dust Test	55
52	Replacement Test, Head and Cover.....	56
53	Marking Label Adhesion Tests.....	56
53.1	General.....	56
53.2	Air oven-aging test.....	56
53.3	Immersion test.....	57
53.4	Standard-atmosphere test.....	57
53.5	Unusual-condition exposure test.....	57
54	Circuit Measurement Test	57
54.1	Current input	57
54.2	Battery trouble voltage determination	57
55	Overvoltage and Undervoltage Tests	60
55.1	General.....	60
55.2	Undervoltage test	61
56	Temperature Test	61
57	Transient Tests.....	64
57.1	General.....	64
57.2	Supply line (high-voltage) transients.....	65
57.3	Internally induced transients	67
57.4	Extraneous transients	67
57.5	Supply line (low-voltage circuit) transients	68
58	Static Discharge Test.....	68
59	Operation Test	69
60	Sensitivity Test Feature.....	69
61	Dielectric Voltage-Withstand Test	69
62	Tests of Thermoplastic Materials.....	70
62.1	Accelerated air-oven aging test.....	70
62.2	Flame test 19 mm (3/4 inch)	71
62.3	Flame test 127 mm (5 inch)	72
62.4	Impact test	73
63	Overload Test.....	73
63.1	Electronic heat detector.....	73
63.2	Separately energized circuits and non-electric type heat detectors	74
63.3	Separately energized circuits.....	74
64	Endurance Tests	74
64.1	Electronic heat detector.....	74
64.2	Separately energized circuits and non-electric type heat detectors	74
65	Polarity Reversal Test.....	75
66	Strain Relief Test	75
67	Battery Tests	75
68	Dynamic Load Immunity Test.....	76
69	Firmware Update (If Provided).....	76
69.1	General.....	76
69.2	Firmware update.....	76
70	Abnormal Operations Test.....	78
71	Conformal Coatings on Printed Wiring Boards	78
71.1	General.....	78
71.2	Low voltage printed wiring boards	78
71.3	High voltage printed wiring boards	80



72	Evaluation of Reduced Spacings on Printed-Wiring Boards	80
73	Heat Detector Characterization for Tenability Monitoring (Optional)	81

MANUFACTURING AND PRODUCTION TESTS

74	General	81
75	Production Line Dielectric Voltage-Withstand Test for High-Voltage Products	82
76	Sensitivity Calibration Tests	82
76.1	Rate-of-rise heat detectors	82
76.2	Fixed-temperature heat detectors	83

MARKING

77	General	83
----	---------------	----

INSTALLATION INSTRUCTIONS

78	General	85
79	Four-Wire Detectors	87
80	Two-Wire Detectors	87
81	Technical Bulletin	88

SPECIALIZED REQUIREMENTS/APPLICATIONS

82	Requirements for Wireless Systems	88
----	---	----

ANNEX A (NORMATIVE) – RELIABILITY PREDICTION AND CRITERIA FOR ACCEPTANCE

INSTRUCTIONS FOR DETERMINING A RELIABILITY PREDICTION OF ELECTRONIC COMPONENTS AND MICROELECTRIC CIRCUITS

A1	Instructions for Determining a Reliability Prediction for Smoke Detectors	90
A2	Methods of Determining Failure Rate	90

CRITERIA FOR ACCEPTANCE OF MICROELECTRONIC DEVICES

A3	General	99
A4	Part I – Quality Assurance Screening Program	99
A5	Part II – Determination of Failure Rate Number Supplemented by Burn-In Test	102
A5.1	General	102
A5.2	Determination sequence	102
A5.3	Test calculations and procedures	103
A5.4	Test conditions	105
A5.5	Failure rate number calculation	107

ANNEX B (INFORMATIVE) – OVEN CONSTRUCTION

B1	Test Oven	109
B1.1	Construction	109

ANNEX C (NORMATIVE) – FRENCH TRANSLATIONS OF REQUIRED MARKINGS

ANNEX D (INFORMATIVE) – Standards for Components

Preface

This is the common ULSE and ULC Standard for Heat Detectors for Fire Protective Signaling Systems. It is the Second edition of CAN/ULC 530 and Eighth edition of ANSI/UL 521.

This Joint Standard was prepared by UL Standards & Engagement Inc. (ULSE), ULC Standards, and the NEMA Technical Harmonization Committee on Notification Appliances. The standard was formally approved by the ULSE Technical Committee on Signal Appliances and the ULC Technical Committee on Fire Alarm and Life Safety Equipment and Systems. The efforts and support of the NEMA Technical Harmonization Committee, ULSE Technical Committee, and ULC Technical Committee are gratefully acknowledged.

Only metric SI units of measurement are used in this Standard. 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.

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.

Annexes [A](#), [B](#) and [C](#) are identified as normative and form a mandatory part of this Standard.

Annex [D](#) is identified as informative and is for informational purposes only.

Note: Although the intended primary application of this Standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of Harmonization

This Standard is published as an equivalent standard for ULSE and ULC Standards. An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical deviations are allowed for codes and governmental regulations and those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental, climatic, geographical, technological or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is to be word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

No Text on This Page

Heat Detectors for Fire Protective Signaling Systems

INTRODUCTION

1 Scope

1.1 These requirements cover heat-actuated fire detectors intended for nonhazardous indoor, unconditioned areas, and outdoor locations, for use as components in automatic fire protective systems, to be installed in accordance installation in accordance with:

a) In Canada:

- 1) The National Building Code of Canada;
- 2) The National Fire Alarm Code of Canada;
- 3) The Standard for the Installation of Fire Alarm Systems, ULC-S524;
- 4) The Canadian Electrical Code, CSA C22.1;

b) In the United States:

- 1) The National Fire Alarm and Signaling Code, NFPA 72;
- 2) The National Electrical Code, NFPA 70.

1.2 These requirements cover:

- a) Fixed-temperature detectors;
- b) Rate-of-rise detectors;
- c) Combination of fixed-temperature detectors and rate-of-rise detectors;
- d) Heat Sensitive Cable; and
- e) Heat Sensitive Tube.

2 Components

2.1 Except as indicated in Components, Section 2, a component of a product covered by this standard shall comply with the requirements for that component.

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

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

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

2.4 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 Units of Measurement

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

4 Referenced Publications

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

4.2 The following publications are referenced in this Standard:

ASA S12.51/ISO 3741, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms*

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM B154-82, *The Mercurous-Nitrate Test for Copper and Copper Alloys*

ASTM MNL 12, *Manual on the Use of Thermocouples in Temperature Measurement*

CSA 22.1, *Canadian Electrical Code*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

MIL-STD-1916, *DoD Preferred Methods for Acceptance of Product* (MIL STD 105E Sampling Procedures and Tables for Inspection by Attributes)

MIL-HDBK 217F, *Reliability Prediction of Electronic Equipment* (MIL-HDBK 217B Reliability Prediction of Electronic Equipment)

MIL-STD 750E, *Test Methods for Semiconductor Devices*

MIL-STD 883H, *Test Methods Standard Microcircuits*
(MIL-STD 883K, Test Methods Standard Microcircuits)
(MIL-STD 883D, Test Methods Standard Microcircuits)
(MIL-STD 883B, Test Methods Standard Microcircuits)

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

NFPA 70, *National Electrical Code*

NFPA 72, *National Fire Alarm and Signaling Code*

NBC, *National Building Code of Canada*

NFC, *National Fire Code of Canada*

CSA C22.2 No. 94.2-15/NMX-J-235/2-ANCE-2015/UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 746E, *Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards*

UL 864, *Control Units and Accessories for Fire Alarm Systems*

UL 985, *Household Fire Warning System Units*

ULC-S524, *Installation of Fire Alarm Systems*

ULC 527, *Control Units for Fire Alarm Systems*

ULC-S540, *Residential Fire and Life Safety Warning Systems: Installation, Inspection, Testing and Maintenance*

ULC-S545, *Residential Fire Warning System Control Units*

5 Glossary

5.1 For the purpose of this standard the following definitions apply.

5.2 ALARM SIGNAL – An audible signal that lasts at least two complete cycles of the “three pulse” temporal pattern to indicate an emergency fire condition.

5.3 COMPONENT, LIMITED-LIFE – 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.

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

5.5 CONFORMAL COATING – A protective covering applied on a printed-wiring board capable of conforming to the configuration of objects coated, used to increase the dielectric voltage-withstand capability between conductors and/or to protect against environmental conditions. Conformal coatings may be used on printed wiring boards where electrical spacings are insufficient between uninsulated live parts of opposite polarity or between such parts and accessible dead-metal parts.

5.6 FIRE DETECTOR – A device which detects a fire condition and automatically initiates an electrical signal to actuate an alert signal or an alarm signal and includes Heat Detectors and Smoke Detectors.

5.7 FIRMWARE – For the purpose of this Standard, software programs residing permanently on a microprocessor or in a non-volatile memory chip within heat detector and accessory devices.

5.8 FIXED-TEMPERATURE DETECTOR – A fire detector designed to operate when the temperature at the detector exceeds a predetermined temperature.

5.9 HEAT DETECTOR – A fire detector designed to operate at a predetermined temperature or rate of temperature rise. Below are types of heat detectors:

- a) ELECTRONIC HEAT DETECTOR – A device that uses electronic circuitry to respond to an abnormal high temperature or rate of temperature rise
- b) LINE-TYPE HEAT DETECTOR – A heat detector in which the thermo-responsive element is continuous along a line. See Heat Sensitive Cable, [5.10](#).
- c) MECHANICALLY-OPERATED-TYPE – A heat detector having a temperature sensitive bimetal or eutectic element with or without 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.
- d) NON-RESTORABLE HEAT DETECTOR – A device whose sensing element is designed to be destroyed in the process of detecting a fire.
- e) RATE-OF-RISE DETECTOR – A detector designed to operate within a specified time when the temperature rise at the detector exceeds a predetermined rate.
- f) RESTORABLE HEAT DETECTOR – A device whose sensing element is not destroyed during intended service by the processes of detecting a fire. Restoration may be manual or automatic.
- g) SELF-RESTORING HEAT DETECTOR – A restorable detector whose sensing element is designed to be returned to normal automatically.
- h) SPOT-TYPE DETECTOR – A detector in which the thermo-responsive element is concentrated at a particular area.
- i) TWO-WIRE DETECTOR – An electronic heat detector that signals over and obtains its power from the initiating device circuit of a fire alarm system control unit. Additional terminals or leads may be provided for annunciation or control of supplementary functions.
- j) TUBE-TYPE HEAT DETECTOR – A heat detector tube in which temperature-responsive polymer element is continuous along the line. See Heat-Sensitive Tube, [5.11](#).

5.10 HEAT-SENSITIVE CABLE – A line type device whose sensitive element comprises two current-carrying wires held separate by heat-sensitive insulation that softens at the rated temperature, thus allowing the wires to make electrical contact.

5.11 HEAT-SENSITIVE TUBE – A line type device whose sensitivity element breaks, melts, or otherwise functions at the rated temperature and pressure to initiate the operation of fire suppression agent over a specified area.

5.12 LOCATIONS:

- a) INDOOR LOCATIONS – Areas that are protected from exposure to the weather.
- b) OUTDOOR LOCATIONS – Areas that are exposed to the weather.

5.13 MANUFACTURER'S PUBLISHED INSTRUCTIONS – Published installation and operating documentation provided for each product or component. The documentation includes directions and necessary information for the intended installation, maintenance, and operation of the product or component.

(Reproduced with permission from NFPA 72®-2022, National Fire Alarm and Signaling Code® Copyright © 2021 National Fire Protection Association. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety which may be obtained through the NFPA website at www.nfpa.org.)

(NFPA 72® and National Fire Alarm and Signaling Code® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA.)

5.14 RISK OF ELECTRIC SHOCK – A risk of electric shock is determined to exist at any part, when:

- a) The potential between the part and earth ground or any other accessible part is more than 42.4 volt peak and
- b) The continuous current flow through a 1500 ohm resistor connected across the potential exceeds 0.5 milliampere.

5.15 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 volt peak, and the energy available to the circuit under any condition of load, including short circuit, results in a current of 8 amperes or more after 1 minute of operation or
- b) A power of more than 15 watts is deliverable into an external resistor connected between the two points.

5.16 TROUBLE SIGNAL – A visible or audible signal intended to indicate a fault or trouble condition.

5.17 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 volts alternating current (AC) (42.4 volts peak) and maximum power of 100 volt-amperes, 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 volts 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.

6 Manufacturers Published Instructions

6.1 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 heat detector. For this purpose, a printed edition is not required.

6.2 The manufacturer's published instructions shall include directions and information deemed by the manufacturer to be required for proper and safe installation, testing, maintenance, operation, and use of the heat detector.

7 Compatibility Information

7.1 General

7.1.1 Compatibility between a two-wire electronic heat detector that receives its power from the initiating device circuit of a fire alarm system control unit is dependent upon the interaction between the circuit parameters, such as voltage, current, frequency, and impedance, of the detector and the initiating device circuit.

7.1.2 A detector that does not receive its power from the initiating device circuit of a control unit (conventionally a detector having four or more wires for field connection or a heat detector with dry contacts) may be employed with any electrically compatible fire alarm system control unit without the need for compatibility consideration as its connection does not impose any load on the initiating circuit. Under an alarm condition, the four-wire detector acts as a switch (similar to a manual station) to place the system in alarm.

7.1.3 As a two-wire detector obtains its power from the initiating device circuit of a system control unit, its operation is dependent on the characteristics of the circuit to which it is connected as the detector imposes a resistive and capacitive load on the circuit. Similarly, the load imposed upon the initiating circuit by a connected detector must not prevent alarm response by a control unit to a detector in alarm, nor prevent a trouble response to an open circuit after the last detector.

7.1.4 The connection of a two-wire electronic heat detector is restricted to the specific control units with which a compatibility evaluation has been made.

7.1.5 A supplementary signaling device [such as an audible appliance, relay, or annunciator lamp (LED)] that is integral with a two-wire heat detector and that is also powered from an initiating device circuit of a fire alarm system control unit shall not be used if its operation, including level of audibility and light output, is inhibited by the operation limitation of the initiating device circuit.

7.2 Method of evaluation

7.2.1 In accordance with Compatible Information, [7.1.1](#) – [7.1.5](#) to determine whether any combination of control unit and electronic heat detector or detectors is compatible, whether the detectors are the same model or a mixture of one or more models or types, the tests indicated in (a) and (b) are to be conducted:

- a) The Dynamic Load Immunity Test, Section [68](#).
- b) The Two-Wire Smoke Detector Compatibility Tests in:
 - 1) In Canada, ULC 527.
 - 2) In the United States, UL 864.

7.2.2 For the test in Method of Evaluation, [7.2.1](#)(b), a load representing the maximum number of detectors intended to be connected to the control unit initiating device circuit, whether one model or a mixture of several models, is to be employed.

7.3 Changes affecting compatibility

7.3.1 To maintain compatibility integrity after installation of a compatible combination that can be affected by replacement detectors or a modification of either the detectors or the control unit, the product that is changed shall be assigned a different model number, or change in compatibility identification marking.

7.3.2 A compatibility identifier marking consists of any six-digit or less alphanumeric combination, such as a date code, part number, model number, or the like used to identify the latest revision that has not resulted in a new model number, but that impacts compatibility.

8 Temperature Designation

8.1 Fixed temperature spot-type heat detectors are designated according to temperature of operation as indicated in [Table 8.1](#).

Table 8.1
Temperature Rating

Temperature rating	Temperature rating range,	
	°C	(°F)
Low	37.8 – 56.7	(100 – 134)
Ordinary	57.2 – 78.9	(135 – 174)
Intermediate	79.4 – 120.6	(175 – 249)
High	121 – 162.2	(250 – 324)
Extra High	163 – 203.8	(325 – 399)
Very Extra High	204 – 259.4	(400 – 499)
Ultra High	260 – 302	(500 – 575)

8.2 Low-degree rated heat detectors apply only to self-restoring type detectors. Low-degree heat detectors are intended only for installation in controlled ambient conditions, such as in a computer room.

ASSEMBLY

9 Mounting

9.1 A heat detector shall be provided with a means for secure mounting, and the mounting shall be independent of the installation wiring.

9.2 The mounting means shall be electrically insulated from current-carrying parts of the device.

9.3 The intended mounting means shall not result in any distortion of the device so as to alter the operating temperature adjustment.

10 Servicing and Maintenance Protection

10.1 A thermo responsive element adjustment shall not be capable of being readjusted after shipment from the factory unless the detector is designed for field adjustment. The means for calibration, if accessible or apparent, shall be modified, guarded, or sealed so that it is not subject to manipulation by hand or ordinary tools following factory calibration.

10.2 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 in a screw, such as a slot or recessed head 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.

10.3 Uninsulated live parts of high-voltage circuits and moving parts within an enclosure that can cause a risk of injury shall be located, guarded, or enclosed to reduce unintentional contact by persons performing service.

10.4 An electrical component that may require examination, adjustment, servicing, or maintenance while energized shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for service without subjecting the user to a risk of electric shock from adjacent uninsulated live parts.

10.5 Manual switching devices may be located or oriented with respect to uninsulated live parts or hazardous moving parts so that manipulation of the mechanism can be accomplished in the normal direction of access if uninsulated live parts or hazardous moving parts are not located in front (in the direction of access) of the mechanism, or not located within 150 mm (5.9 inches) of any side or behind the mechanism, unless guarded.

10.6 In determining compliance with [10.5](#), only uninsulated live parts in circuits above 30 Vrms shall be considered.

10.7 The following shall not be considered uninsulated live parts:

- a) Coils of controllers, relays, and solenoids, and transformer windings, when the coils and windings are provided with insulating overwraps;
- b) Enclosed motor windings;
- c) Terminals and splices with suitable insulation; and
- d) Insulated wire.

CONSTRUCTION

11 General

11.1 A heat detector shall be constructed so that its operation, when installed, will not be significantly affected by dust, insects, and other foreign material.

11.2 A detector shall be constructed so that

- a) It is reliable and consistent in operation,
- b) Parts will not become displaced during shipment or after installation, or while being maintained.

12 Materials

12.1 If a sealing compound is used, its melting point shall be at least 8.3 °C (15 °F) higher than the temperature rating of the thermostat, but not less than 65 °C (149 °F).

12.2 Diaphragms and spring parts shall be made of a nonferrous material such as phosphor bronze, nickel silver, or the equivalent. If ferrous materials are employed, they shall be hermetically sealed or plated so as not to be affected by corrosion.

12.3 A fusible alloy, if used as the operating member of a heat detector, shall not be affected by the conditions to which it will be exposed in service, as represented by the tests described in the Performance section of this standard.

12.4 All exposed parts that could be affected by corrosion shall be protected by enameling, galvanizing, sherardizing, plating, or equivalent means.

12.5 Polymeric materials of a heat detector shall be constructed to resist the abuses likely to be encountered in service. The degree of resistance to abuse inherent in the detector shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects, which alone or in combination result in an increase in the risk of fire, electric shock, or injury to persons.

13 Corrosion Protection

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

Exception: Parts made of stainless steel, polished or treated when required, do not require additional protection.

13.2 The requirement of [13.1](#) applies to all enclosures, whether of sheet steel or cast iron, and to all springs and other parts upon which proper operation depends. It does not apply to minor parts such as washers, screws, and bolts, when the deterioration of such unprotected parts does not result in noncompliance with this standard, result in a hazardous condition, or impair the operation of the heat detector.

13.3 Bearing surfaces shall be of such materials that reduce the risk of binding due to corrosion.

13.4 Metal shall not be used in combinations such as to result in galvanic action that results in deterioration, such as a loss in the properties of a material, reduction in metal thickness to mechanical failure, structure failure, breakdown, reduction in value, or similar deterioration, of cabinets or enclosures.

13.5 Hinges and other attachments shall be resistant to corrosion.

13.6 Nonferrous cabinets and enclosures do not require special corrosion protection.

14 Enclosures

14.1 General

14.1.1 The enclosure of a heat detector shall be constructed sufficiently strong and rigid to resist the abuses encountered in service. The degree of resistance to abuse inherent in the detector shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects that, alone or in combination, present a risk of fire, electric shock, or injury to persons.

14.1.2 Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be evaluated in determining compliance with the requirement of [14.1.1](#).

14.1.3 All electrical parts of a heat detector, 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.

14.1.4 The enclosure of a heat detector 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 detector. The removal of a completely assembled panel or cover to mount the detector is not identified as disassembly of an operating part.

14.1.5 When the heat detector 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.

14.2 Cast metal enclosures

14.2.1 The thickness of cast metal for an enclosure shall be as indicated in [Table 14.1](#). When cast metal having a thickness 0.8 mm (1/32 inch) less than that indicated in [Table 14.1](#) 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.

Table 14.1
Cast-Metal Enclosures

Use or dimensions of area involved	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast,	
	mm	(in)	mm	(in)
Area of 155 cm ² (24 in ²) or less and having no dimension greater than 152 mm (6 inches)	1.6	(1/16) ^a	3.2	(1/8)
Area greater than 155 cm ² (24 in ²) or having any dimension greater than 152 mm (6 inches)	2.4	(3/32)	3.2	(1/8)
At a threaded conduit hole	6.4	(1/4)	6.4	(1/4)
At an unthreaded conduit hole	3.2	(1/8)	3.2	(1/8)
^a The area limitation for metal 1.6 mm (1/16 inch) thick is obtained by the provision of reinforcing ribs subdividing a larger area.				

14.2.2 When 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 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.

14.2.3 When 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.

14.3 Sheet metal enclosures

14.3.1 The thickness of sheet metal used for the enclosure of a detector shall not be less than that indicated in [Table 14.2](#). When sheet metal of up to two gage sizes lesser thickness is used, the surface under consideration shall be curved, ribbed, or otherwise reinforced, or the shape of the surface, size of the surface, or both shall be such that equivalent mechanical strength is provided.

Table 14.2
Sheet Metal Enclosures

Maximum dimensions of enclosure				Minimum thickness of sheet metal						
				Steel					Brass or aluminum	
Length or width		Area		Zinc-coated			Uncoated			
mm	(in)	cm ²	(in ²)	mm	(in)	GSG	mm	(in)	GSG	mm (in) AWG
305	(12)	581	(90)	0.86	(0.034)	20	0.81	(0.032)	20	1.14 (0.045) 16
610	(24)	2322	(360)	1.14	(0.045)	18	1.07	(0.042)	18	1.47 (0.058) 14
1219	(48)	7742	(1200)	1.42	(0.056)	16	1.35	(0.053)	16	1.91 (0.075) 12
1524	(60)	9678	(1500)	1.78	(0.07)	14	1.70	(0.067)	14	2.41 (0.095) 10
Over 1524	(Over 60)	Over 9678	(Over 1500)	2.46	(0.097)	12	2.36	(0.093)	12	3.10 (0.122) 8

14.3.2 At any point where conduit or metal-clad cable is to be attached, sheet metal shall have a thickness of not less than 0.81 mm (0.032 inch) when of uncoated steel, not less than 0.86 mm (0.034 inch) when of galvanized steel, and not less than 1.14 mm (0.045 inch) when of nonferrous metal.

14.3.3 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 inch) or 0.81 mm (0.032 inch) nonferrous metal for a hole having a 34.9 mm (1-3/8 inch) diameter maximum dimension.

14.3.4 A closure for a hole larger than 34.9 mm (1-3/8 inch) diameter shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used.

14.3.5 A knockout in a sheet metal enclosure shall be secured and shall be able to be removed without undue deformation of the enclosure.

14.3.6 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 [24](#).

14.4 Nonmetallic enclosures

14.4.1 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 14.2](#). See also the Tests of Thermoplastic Materials, Section [62](#).

14.4.2 The continuity of any grounding system to which a detector is to be connected shall not rely on the dimensional integrity of the nonmetallic material.

14.4.3 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 inch) as described in [62.3.1](#) – [62.3.6](#).
- b) Enclosures containing Class 2 and Class 3 circuits with a voltage not exceeding 30 volts AC, 42.4 volts-peak, or 60 volts DC – minimum flammability rating of HB and compliance with the Flame Test 19 mm (3/4 inch), as described in [62.2.1](#) – [62.2.6](#).
- c) Enclosures containing circuits powered by batteries with energy limited to 15 watts – minimum flammability rating of HB.

14.5 Ventilating openings

14.5.1 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 inch). 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.

14.5.2 Except as noted in [14.5.3](#), perforated sheet metal used for expanded metal mesh shall not be less than 1.07 mm (0.042 inch) in average thickness, 1.17 mm (0.046 inch) when zinc coated.

14.5.3 When the indentation of the guard or enclosure does not alter the clearance between uninsulated live parts and grounded metal so as to reduce spacings below the minimum values required [0.53 mm (0.021 inch) expanded metal mesh or perforated sheet metal, 0.61 mm (0.024 inch) when zinc coated], the following conditions shall be employed:

- a) The exposed mesh on any one side or surface of the product has an area of not more than 465 cm² (72 in²) and has no dimension greater than 305 mm (12 inches); or
- b) The width of an opening so protected is not greater than 88.9 mm (3.5 inches).

14.5.4 The wires forming a screen protecting high-voltage current-carrying parts shall not be smaller than AWG 16 (1.3 mm²) and the screen openings shall not be greater than 3.2 cm² (1/2 in²) in area.

14.6 Covers

14.6.1 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 detector.

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

Exception: This requirement does not apply to the battery replacement aspect of a heat detector employing a battery as the main or standby supply.

14.6.2 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.

14.6.3 When a heat detector cover is not intended to be removed for cleaning, maintenance, or both, and the detector 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.

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

14.6.4 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 an detector employing high-voltage circuits: "Circuit Fuse(s) Inside – Disconnect Power Prior To Servicing" « Fusible(s) à L'intérieur – Déconnecter avant de procéder à L'entretien ».

14.6.5 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.

14.7 Glass panels

14.7.1 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 14.3](#).

14.7.2 A transparent material other than glass employed as a cover over an opening in an enclosure shall:

- a) Be mechanically equivalent to that of glass;
- b) Not distort; and
- c) Not become less transparent at the temperature to which it is subjected under normal or abnormal service conditions.

Table 14.3
Thickness of Glass Covers

Maximum size of opening					
Length or width		Area		Minimum thickness	
mm	(inch)	cm ²	(in ²)	mm	(inch)
102	(4)	103	(16)	1.6	(1/16)
305	(12)	929	(144)	3.2	(1/8)
Over 305	(Over 12)	Over 929	(Over 144)	See footnote a	See footnote a
^a 3.2 mm (1/8 inch) or more, based upon the size, shape, and mounting of the glass panel. A glass panel for an opening having an area greater than 929 cm ² (144 in ²), or having any dimension greater than 305 mm (12 inches), shall be supported by a continuous groove not less than 4.8 mm (3/16 inch) deep along all four edges of the panel.					

14.7.3 A lens, light filter, or similar part of a heat detector shall be constructed of a material whose transparency is not diminished by the conditions to which it is exposed in service, as represented by the Performance Tests of this standard. See Sections [25](#) – [72](#).

15 Field-Wiring Connections

15.1 General

15.1.1 A heat detector 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 following corresponding to the rating of the unit:

- a) In Canada, C22.1-18;
- b) In the United States, NFPA 70.

15.2 Field-wiring compartment

15.2.1 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.

15.2.2 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.

15.3 Field-wiring terminals

15.3.1 A field-wiring terminal to which field-wiring connections are made shall comply with the requirements in [15.3.2](#) – [15.3.5](#) and:

- a) UL 310/CSA C22.2 No.153;
- b) In Canada only:
 - 1) CSA C22.2 No. 65;
 - 2) UL 486E; or
 - 3) CSA C22.2 No. 158, rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.
- c) In the United States only:
 - 1) UL 486A-486B;
 - 2) UL 486E; or
 - 3) UL 1059, rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.

15.3.2 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 5.2 mm (No. 10) and larger wires. When the connectors or lugs are secured to a plate, the plate thickness shall not be less than 1.3 mm (0.050 inch) thick. Securing screws of plated steel have been determined to meet the requirements.

15.3.3 A wire-binding screw used at a wiring terminal shall not be smaller than 4.2 mm (No. 8) diameter. Plated screws are not prohibited.

Exception: A 3.5 mm (No. 6) diameter screw is appropriate for use for the connection of 2.1 mm (No. 14) and a 2.8 mm (No. 4) diameter screw is appropriate for use for the connection of a 0.65 mm (No. 19) or smaller conductor.

15.3.4 Terminal plates tapped for wire-binding screws shall:

- a) Have not less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or the equivalent, to hold the wires in position. Other constructions may be used if they provide equivalent thread security of the wire-binding screw.
- b) Be of a nonferrous metal not less than 1.3 mm (0.050 inch) thick when used with a 4.2 mm (No. 8) diameter or larger screw, and not less than 0.76 mm (0.030 inch) thick when used with a 3.5 mm (No. 6) diameter or smaller screw.

15.3.5 When two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be used for each additional conductor. A separator washer is not required when two conductors are separated and intended to be secured under a common clamping

plate. When the wires protrude above terminal barriers, the nonferrous separator shall include means, such as upturned tabs or sides, to retain the wire.

15.3.6 Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits supplying operating power to the detector (where the operating power is monitored by an end-of-line device) and for circuits transmitting alarm signals from the detector to the control unit, one for each incoming and one for each outgoing wire. A common terminal may be used in lieu of duplicate terminals when it is intended to prevent the looping of an unbroken wire around or under a terminal screw in a manner that permits the looped wire to remain unbroken during installation, thereby precluding monitoring in the event the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw, where separate conductors are intended to be inserted in each notch, is an equivalent arrangement. When duplicate terminals or leads are used and there is no provision to prevent looping an unbroken wire around or under one terminal, the marking in [78.2\(c\)](#) shall be provided.

15.3.7 If wire leads are used in lieu of wiring terminals, they shall be not smaller than 18 AWG, not less than 150 mm in length, provided with strain relief, and employ a minimum 0.08 mm wall of insulation, or the equivalent. They shall also conform to the temperature limit of the product.

15.3.8 Uninsulated live parts shall be secured to the base or mounting surface so that they shall not turn or shift in position, when it is possible that such motion results in a reduction of spacings, below the acceptable values See Spacings, Section [24](#). Friction between surfaces shall not be used as a means to prevent shifting or turning of live parts, a lock washer applied as intended is permissible.

15.3.9 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 shall not turn or shift in position when such motion results in reduction of spacings below the minimum values required. This is to be accomplished by two screws or rivets, by square shoulders or mortices, by a dowel pin, lug, or offset, by a connecting strap or clip fitted into an adjacent part, or by any method determined to be equivalent.

15.4 Special field-wiring connections (qualified application)

15.4.1 Any of the following terminal configurations are suitable for connection of field wiring when all of the conditions in [15.4.2](#) are met:

- a) Quick-Connect Terminals – Nonferrous, quick-connect (push-type) terminals consisting of male posts permanently secured to the device and provided with compatible, female connectors for connection to field wiring. These require a special tool for crimping of field wires. Mating terminals shall be shipped with the control unit with instructions for their installation;
- b) Push-In Terminals – Nonferrous, push-in terminals (screwless) of the type used on some switches and receptacles. Solid conductors are pushed into slots containing spring-type contacts. The leads are removable by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals are not to be used with aluminum conductors. The marking adjacent to the terminal shall indicate that copper conductors only are to be used; and
- c) Other Terminals – Other terminal connections are not prohibited when determined to be equivalent to (a) and (b) and are limited to the same restrictions.

15.4.2 Any of the terminal configurations listed in [15.4.1](#) are appropriate for connection of field wiring provided all of the following indicated conditions are met:

- a) When a special tool is required for connection, it shall be provided and its use indicated on the installation wiring diagram by name of the manufacturer and the model number or equivalent;

- b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size to be used shall not be less than 26 AWG (0.13 mm²) for a jacketed, multi-conductor cable or 18 AWG (0.82 mm²) for a single conductor wire;
- c) The wire size to be used shall be rated for the current-carrying capacity of the circuit application; and
- d) The special field-wiring terminal assembly shall comply with the strain relief test as outlined in Section [66](#), Strain Relief Test (special field-wiring terminals).

15.5 Field wiring leads

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

15.5.2 Leads provided for field connection to power limited fire protective signaling circuits, such as employed for multiple station interconnection or those used for connection to remote signaling devices, shall not be smaller than AWG 16 (1.3 mm²) for a single conductor, AWG 19 (0.65 mm²) for two or more conductors, and AWG 22 (0.32 mm²) 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 AWG 18 (0.82 mm²) and larger conductors.

15.5.3 For a heat sensitive cable, the stripped ends of each wire shall be used for field connections. See Section [28](#), Current Carrying Parts.

15.6 Special field-wiring terminals

15.6.1 To determine suitability as a field-wiring connection in compliance with [15.4](#), (special field wiring connections) representative samples shall comply with all of the tests specified in [15.6.2](#) and [15.6.3](#).

15.6.2 A terminal connection shall withstand the application of a straight pull of 22.2 N (5 lbf), applied for 1 minute to the wire in the direction which would most likely result in pullout, without separating from the terminal.

15.6.3 Six samples of the terminal are to be connected to the wire sizes with which they are intended to be used, in accordance with the manufacturer's published instructions. When a special tool is required to assemble the connection, it is to be used. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 22.2 N (5 lbf) is reached and maintained at 22.2 N (5 lbf) for 1 minute.

15.7 Grounding terminals and leads

15.7.1 A hazardous-voltage detector which is provided with an overall nonmetallic enclosure and cover, is intended to be serviced internally, and employs internal dead metal parts which become energized under fault conditions, requires an equipment grounding terminal or lead, or the equivalent.

15.7.2 An equipment grounding terminal or lead is not required for:

- a) An extra-low voltage detector;
- b) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover and that is not intended to be internally serviced; or
- c) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover and:

1) That does not employ internal dead-metal parts which are energized under a fault condition and be contacted during servicing, or

2) Having internal dead metal parts that are insulated; or

d) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover that includes internal dead metal parts which are contacted during servicing, and employs a 2-pole disconnect switch which de-energizes both legs of the supply circuit upon removal of the cover.

15.7.3 The grounding means shall be connected to all exposed dead metal parts that become energized and all dead metal parts within the enclosure that are exposed to contact during servicing and maintenance in accordance with [22.2](#), Bonding for grounding.

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

Note: In Canada, there are two official languages, French and English. Attention is drawn to the fact that some Canadian authorities may require markings to be in both official languages. Annex [C](#) lists acceptable French translations of the markings specified in this standard.

15.8 Grounded supply terminals and leads

15.8.1 A field wiring terminal for the connection of the grounded supply 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 identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

15.8.2 A field wiring lead provided for connection of the grounded supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from other leads, and no other leads visible to the installer, other than grounded conductors, shall be so identified.

15.8.3 A terminal or lead identified for the connection of the grounded supply conductor shall not be electrically connected to a single-pole manual switching device which has an OFF position or to a single-pole over-current (not thermal) protective device.

15.9 Isolated (nongrounded) detectors

15.9.1 When a detector is constructed such that the exposed metal enclosure serves as a current-carrying part of the circuit, an insulated (nonmetallic) mounting plate, or a metal mounting plate with insulated bushed holes through which metal mounting screws are employed, or an equivalent arrangement shall be provided for installation between the detector current-carrying parts and metal back box.

15.9.2 The arrangement described in [15.9.1](#) is permitted only on a detector intended for connection to a low-voltage circuit. In addition, the word "CAUTION" « MISE EN GARDE » and the following or equivalent marking is to be displayed in letters at least 3.2 mm (1/8 inch) high adjacent to the detector wiring area:

"INSTALL ENCLOSURE ISOLATED FROM GROUND PER MANUFACTURER'S INSTRUCTIONS AND HARDWARE PROVIDED. GROUNDING COULD RESULT IN A FALSE ALARM."

« INSTALLER ENCEINTE ISOLE DE LA TERRE SELON LES INSTRUCTIONS ET MATERIELS DU CONSTRUCTEUR PREVUE. TERRE POURRAIT ENTRAINER UNE FAUSSE ALARME ».

15.9.3 Except as permitted by [15.9.11](#), an equipment-grounding terminal or lead shall be provided in a heat detector intended for connection to other than a 30 V rms or less energy limited source of supply by means of other than metal enclosed wiring system.

15.9.4 The grounding means shall be reliably connected to all exposed dead metal parts which are liable to become energized and all dead metal parts within the enclosure which are exposed to contact during servicing and maintenance.

15.9.5 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes and no other leads visible to the installer, other than grounding conductors, shall be so identified.

15.9.6 A field wiring terminal intended for connection of an equipment grounding conductor shall be plainly identified, such as being marked "G", "GR", "Ground", "Grounding", or the equivalent, or with this symbol:  or by a suitable marking on a wiring diagram provided on the heat detector. The field wiring terminal shall be so located that it is unlikely to be removed during normal servicing of the detector.

15.9.7 A field wiring terminal for the connection of an identified supply 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 identified supply conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

15.9.8 A field wiring lead provided for connection of an identified supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from other leads and no other leads, other than identified supply conductors, shall be so identified.

15.9.9 A terminal or lead identified for the connection of the identified supply conductor shall not be electrically connected to a single-pole manual switching device which has an off position or to a single-pole over-current (not thermal) protective device.

15.9.10 The grounding means for a cord-connected heat detector shall consist of a separate ground lead integral with the supply cord and terminating in the grounding pin of a parallel blade attachment plug.

15.9.11 An equipment grounding terminal or lead is not required for a heat detector provided with an overall nonmetallic enclosure and cover and which is not intended to be internally serviced or a heat detector provided with an overall nonmetallic enclosure and cover and does not employ internal dead-metal parts which may be energized under a fault condition and which can be contacted during servicing.

15.9.12 A hazardous-voltage detector that is provided with an overall nonmetallic enclosure and cover, is intended to be serviced internally, and employs internal dead metal parts which become energized under fault conditions, requires an equipment grounding terminal or lead, or the equivalent.

15.9.13 An equipment grounding terminal or lead is not required for:

- a) An extra-low voltage detector;
- b) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover and that is not intended to be internally serviced; or
- c) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover, and

1) That does not employ internal dead-metal parts which are energized under a fault condition and be contacted during servicing; or

2) Having internal dead metal parts that are insulated; or

d) A hazardous-voltage detector provided with an overall nonmetallic enclosure and cover that includes internal dead metal parts which are contacted during servicing, and employs a 2-pole disconnect switch which de-energizes both legs of the supply circuit upon removal of the cover.

15.9.14 The grounding means shall be connected to all exposed dead metal parts that become energized and all dead metal parts within the enclosure that are exposed to contact during servicing and maintenance in accordance with [22.2](#), Bonding for grounding.

16 Strain Relief

16.1 A strain relief means shall be provided for the field supply leads and for all internally connected wires subject to movement during installation, operation, or servicing of the product to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of leads provided with a ring-type strain relief or equivalent means shall neither damage internal connections or components nor result in reduction of electrical spacings.

16.2 Each lead employed for field connections or an internal lead subjected to movement or handling during installation and servicing shall be capable of withstanding for 1 minute, a pull force of 4.5 N without any evidence of damage or of transmitting the stress to internal connections.

MECHANICALLY OPERATED HEAT DETECTORS

17 Operating Mechanisms

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

17.2 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.

18 Mechanical Assembly

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

18.2 A heat detector shall be so constructed that parts will not become displaced during or after installation.

18.3 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 inch). The obstruction means is to be attached securely in place. See Section [44](#), Vibration Test.

19 Power Supervisory Feature

19.1 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 detector, or other means determined to be equivalent.

ELECTRICALLY OPERATED HEAT DETECTORS

20 Accessories

20.1 Unless specifically indicated otherwise, the construction requirements specified for a detector shall apply also for any remote accessories with which it is to be used.

21 Supplementary Signaling Features

21.1 A supplementary signaling device [such as an audible appliance, relay, or annunciator lamp (LED)] that is integral with a two-wire heat detector and that is also powered from an initiating device circuit of a fire alarm system control unit shall not be used if its operation, including level of audibility and light output, is inhibited by the operation limitation of the initiating device circuit.

22 Internal Wiring

22.1 General

22.1.1 The internal wiring of a detector 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.

22.1.2 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.

22.1.3 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 inch) diameter or less, shall not be less than 0.43 mm (0.017 inch). 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 inch).

22.1.4 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.

22.1.5 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.

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

22.1.7 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.

22.1.8 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.

22.1.9 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.

22.1.10 A metal barrier shall have a thickness at least equal to that required by [Table 14.1](#), as determined by the size of the barrier. A barrier of insulating material shall not be less than 0.71 mm (0.028 inch) 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 inch).

22.2 Bonding for grounding

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

22.2.2 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 service person servicing or operating the equipment.

22.2.3 Metal parts as described below are not required to comply with the requirement of [22.2.2](#):

- a) Adhesive attached metal foil markings, screws, handles, or similar items that are located on the outside of the detector 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 inch) thick and secured in place.

22.2.4 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.

22.2.5 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.

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

22.2.7 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.

22.2.8 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.

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

23 Electrical Components

23.1 General

23.1.1 Mounting of components

23.1.1.1 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 switch mounting means is constructed so that it is not loosened by the switch operation.*
- 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 [24](#).

23.1.1.2 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.

23.1.1.3 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.

23.1.2 Operating components

23.1.2.1 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.

23.1.2.2 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.

23.1.3 Current-carrying parts

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

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

23.1.4 Electrical insulating material

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

23.1.4.2 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.

23.1.4.3 Polymeric materials shall not be used for the sole support of uninsulated live parts unless found to be equivalent to the materials indicated in [23.1.4.1](#).

23.1.4.4 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 inch) thick. Material less than 1.6 mm (1/16 inch) thick shall not be employed unless the panel is supported or reinforced to provide equivalent rigidity.

23.1.4.5 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.

23.1.4.6 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 inch).

23.2 Bushings

23.2.1 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.

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

23.2.3 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.

23.2.4 Fiber 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 inch) thick, with a minus tolerance of 0.4 mm (1/64 inch) for manufacturing variations; and

c) It is not affected adversely by normal ambient humidity conditions.

23.2.5 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.

23.2.6 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 inch) thick and shall fill completely the space between the grommet and the metal in which it is mounted.

23.3 Visual indicators and lamps

23.3.1 Lampholders and lamps shall be rated for the circuit in which they are employed when the detector is operated under any condition of normal service.

23.3.2 A lampholder shall be installed so that uninsulated live parts other than a screw shell will not be exposed to contact by persons removing or replacing lamps in normal service.

23.3.3 A lampholder employing a metal shell, such as a screw shell, used in a circuit rated at 30 Vrms or greater shall be wired so that the metal shell is connected to an identified (grounded circuit) conductor.

23.3.4 When more than one lampholder employing a metal shell is provided, the metal shells of all such lampholders shall be connected to the same grounded circuit conductor.

23.3.5 A lamp or equivalent means shall be provided on a spot detector head or base to identify it as the unit from which the alarm was initiated.

23.3.6 When a detector has more than one lamp, lamp colors are required as follows:

- a) A "power-on" lamp, white or green;
- b) An alarm indicating lamp, red; and
- c) A trouble lamp, amber or yellow.

When the "power-on" lamp is of a different color it shall be marked to identify the function.

23.3.7 When two or more color indications are used to visually annunciate detector status, one color shall be designated for normal indication and mode of operation. If the color for normal operation is other than white or green, the lamp shall be marked to identify the function. An alarm indication shall be red. Use of alternate colors or indication flash rates for non-alarm conditions shall be permitted.

23.3.8 A means shall be provided to indicate a latched-in alarm condition. The indication shall be red and shall be distinctive from the normal state. If flashing is used, the flash rate shall be no less than 12 flashes per minute in the alarm condition.

23.4 Protective devices

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

23.5 Printed-wiring boards

23.5.1 Printed-wiring boards shall be suitable for the application. The securing of components to the board shall be made in the intended manner and the spacings between circuits shall comply with the