

**NATIONAL STANDARD
OF CANADA**

**CAN/ULC-S526:2016-REV1
(Including Revision 1)**

**VISIBLE SIGNALING DEVICES FOR FIRE ALARM AND
SIGNALING SYSTEMS, INCLUDING ACCESSORIES**

Prepared and Published by:



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ANSI/UL 1638-2017



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CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

Standard for Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories,
CAN/ULC-S526:2016-REV1

Fourth Edition, Dated January 28, 2016

Summary of Topics

The September 2017 revision of CAN/ULC-S526:2016 contains the following changes in requirements:

- 1. Addition of Visual Signal Pulse Width Marking, Clause 6.2**
- 2. Revisions to Clause 7.10, Abnormal Operation and Burnout Test, to resolve the binational differences between Canada and the United States and to insert any missing requirements that were accidentally omitted during the creation of the original binational document**
- 3. Revisions to clarify the temperature conditioning requirements for indoor and outdoor use appliances in Mechanical Strength Tests for Enclosures, Section 7.20**
- 4. Additional reference document changes and corrections to existing requirements in CAN/ULC-S526**

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated November 18, 2016.

A “(REV1)” marker in Bold will be inserted at the start of the applicable Clause(s) and in the applicable Subsection title(s). The Subsection title markers will appear in the TOC as a result. The markers may be found by searching for the characters “(REVx)”. Including the parenthesis in the search term will find the markers, without also finding every page header.

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Document ID: 123456789

Prepared by:



**ULC Standards
CAN/ULC-S526
Fourth Edition**



**Underwriters Laboratories Inc
UL 1638
Fifth Edition**

Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories

January 28, 2016

(Title Page Reprinted: September 6, 2017)



ANSI/UL 1638-2017

Approved by



**Standards Council of Canada
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This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through September 6, 2017. The most recent designation of ANSI/UL 1638 as an American National Standard (ANSI) occurred on September 6, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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ULC Preamble

International Classification for Standards (ICS): 13.220.20; 13.320.

This Standard has been developed in compliance with the requirements of SCC for accreditation of a Standards Development Organization.

The Amendment to the Fourth Edition of this ULC Standard was based on, and supersedes, the Fourth Edition.

Attention is drawn to the possibility that some of the elements of this Canadian standard 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 Standard should be sent to ULC Standards. 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.

The review and action to revise or reaffirm this Standard will not exceed 5 years from the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

This Standard is intended to be used for conformity assessment.

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Preface

This is the common UL and ULC Standard for Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories. It is the fourth edition of CAN/ULC-S526 and fifth edition of ANSI/UL 1638.

This Joint Standard was prepared by Underwriters Laboratories Inc., ULC Standards, and the NEMA Technical Harmonization Committee on Notification Appliances. The standard was formally approved by the UL Standards Technical Panel 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, the UL Standards Technical Panel, and the 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.

This standard has been approved as a National Standard of Canada by the Standards Council of Canada.

This standard has been approved by the American National Standards Institute as an American National Standard.

Annexes A, B, and D are identified as informative and are for informational purposes only. Annex C is identified as normative and forms a mandatory part of this Standard.

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 UL 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.

1 Scope

1.1 This standard applies to visual signaling devices intended for indoor and/or outdoor installation:

a) In Canada, in accordance with CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations; and with CAN/ULC S524, Standard for Installation of Fire Alarm Systems. Refer to CAN/ULC S525 Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories, CAN/ULC-S541, Speakers for Fire Alarm and Signaling Systems, Including Accessories, for requirements pertaining to audible devices and speakers.

b) In the United States in accordance with the National Electrical Code, NFPA 70, and the National Fire Alarm and Signaling Code, NFPA 72.

1.2 These requirements cover visible signal devices for use in ordinary (non-hazardous) indoor locations and outdoor locations. This includes:

a) Flashing visual devices used for fire alarm or emergency signaling in both public mode and private mode as defined in the glossary

b) Emergency warning used to notify occupants that an emergency exists.

c) Informative type visual signaling devices connected to or controlled by fire alarm or other emergency signaling system equipment, or both.

1.3 This standard also applies to protective covers and accessories used with visible signals.

1.4 This standard does not apply to visual signaling devices not intended for emergency signaling applications and intended for operation on Class 2 signal circuits as defined in

a) In Canada, CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations,

b) In the United States, the National Electrical Code, NFPA 70.

1.5 Visible signaling devices for use in hazardous or corrosive locations shall comply with the requirements of this Standard and the applicable requirements of:

a) In Canada, CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, with respect to the location hazard.

b) In the United States, the National Electrical Code, NFPA 70.

Note: In the United States, general signaling appliances are covered by UL 464A.

1.6 A supplementary audible signal, incorporated as part of a visible signaling device which is intended for fire alarm application shall comply with the requirements of this Standard and the applicable requirements of:

a) In Canada, CAN/ULC-S525, Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories, and CAN/ULC-S541, Speakers for Fire Alarm and Signaling Systems, Including Accessories,

- b) In the United States, Standard for Audible Signal Appliances for Fire Alarm and Signaling Systems, Including Accessories, UL 464, and Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories, UL 1480.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Annex A for a list of Standards that apply to components generally used in the products covered by this Standard.

2.1.2 A component need not comply with a specific requirement that:

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

2.1.3 A component shall be used in accordance with rating(s) established by its manufacturer for the intended conditions of use.

2.2 Units of Measurement

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

2.2.2 The metric unit shall be designated as the official unit for purposes of this standard. Where values of measurement are specified in both SI and English units, either unit is used. In cases of dispute, the metric unit shall be used. Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2.3 Wherever the abbreviation "AWG" appears in these requirements, it refers to American Wire Gauge.

2.3 Control Unit Interface

2.3.1 A visible signaling device incorporating circuitry for functional interfacing with a control unit for purposes such as supervision, point addressing, multiplexing, synchronization etc., shall also comply with the applicable functional requirements of standards such as:

- a) In Canada, CAN/ULC-S527, Control Units for Fire Alarm Systems;
- b) In the United States, Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

2.4 Reference Publications

2.4.1 **(REV1)** The documents shown below are referenced in the text of this Standard. 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 this standard was approved. All undated references shall be interpreted as referring to the latest edition of that document.

UL Standards

UL 94

Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 224

Extruded Insulating Tubing

UL 464

Standard for Audible Signal Appliances for Fire Alarm and Signaling Systems, Including Accessories

UL 746C

Polymeric Materials – Use in Electrical Equipment Evaluations

UL 796

Standard for Printed Wiring Boards

UL 864

Standard for Control Units and Accessories for Fire Alarm Systems

UL 969

Marking and Labeling Systems

UL 1004-1,

Rotating Electrical Machines – General Requirements

UL 1004-2,

Machines - General Requirements

UL 1004-3,

Thermally Protected Motors

UL 1480

Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories

UL 60065

Audio, Video, and Similar Electronic Apparatus – Safety requirements

UL 60384-14

Fixed Capacitors for Use in Electronic Equipment - Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains

ULC Standards

CAN/ULC-S524

Standard for Installation of Fire Alarm Systems

CAN/ULC-S525

Audible Signaling devices for Fire Alarm and Signaling Systems, Including Accessories

CAN/ULC-S527

Control Units for Fire Alarm Systems

CAN/ULC-S541

Speakers for Fire Alarm and Signaling Systems, Including Accessories

ASTM Standards

ANSI/ASTM B86

Specifications for Zinc-Alloy Die Castings

ASTM B117

Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM E27-81

Standard Method of Spectrochemical Analysis of Zinc-Base Alloys and High-Grade Zinc by the Solution Residue-DC Arc Technique

ASTM E28

Standard Test Methods for Softening Point by Ring-and-Ball Apparatus

CSA Group Standards

C22.1-15

Canadian Electrical Code, Part I, Safety Standard for Electrical Installations

C22.2 No. 0.15-01 (R2012)

Adhesive Labels

CAN/CSA-C22.2 No. 0.4-04 (R2009)

Bonding of Electrical Equipment

CAN/CSA-C22.2 No. 0.17-00 (R2009)

Evaluation of Properties of Polymeric Materials

C22.2 No. 77-95 (R2009)

Motors with Inherent Overheating Protection

CAN/CSA-C22.2 No. 198.1-06 (R2010)
Extruded Insulating Tubing

CAN/CSA-C22.2 No. 60065-03 (R2012)
Audio, Video, and Similar Electronic Apparatus – Safety Requirements

IEC Standards

IEC 60651
Sound Level Meters

ISO Standards

ISO 8201
Acoustics – Audible emergency evacuation signal

National Research Council of Canada (NRC) Standards

NBC 2010
National Building Code of Canada

3 GLOSSARY

For the purpose of this Standard, following definitions apply:

3.1 CANDELA – For the purpose of this Standard, the light output of a flashing light is measured with an integration radiometer and the summation of light intensity over time (I_{dt}) is used in the following equation to determine the effective light intensity. The candela (cd) value assigned to a flashing light is calculated and corresponds to the same value of candela of a fixed light operating under identical conditions of observation, color, size, and shape:

$$Cd = (I_{dt}) / (0.2 + t_2 - t_1)$$

In which:

I_{dt} is the measured lumens recorded by the photometer over time for ten consecutive pulses;

0.2 is two-tenths of 1 s, the value which represents night-time threshold effective illumination as specified in the Illuminating Engineering Society of North America Lighting Handbook; and

$t_2 - t_1$ represents the time period of the light pulse.

3.2 CONSTANT TEMPERATURE – Temperature is considered to be constant when three successive readings indicate no change when taken at intervals of 10% of the previously elapsed duration of the test, but not less than at 5 min intervals.

3.3 CRITICAL ANGLE – The five-degree (5°) dispersion angle that has the lowest ratio of measured light output to minimum required light output for all five-degree increments within the plane of measurement. This angle is identified by comparison of all ratios of measurements obtained within the plane during the tests specified in 7.3, Measurement of effective luminous intensity (light output). All ratios of measured light to required minimum light shall be equal to or greater than 1. For example:

Ratio = Measured light/minimum required light

15 cd / 12 cd

$5/4 = 1.25$

3.4 DUTY CYCLE – The ratio of the sum of all pulse durations to the total period, during a specified period of continuous operation.

3.5 EFFECTIVE LUMINOUS INTENSITY – The quantity of directly perceived light produced by a visible signal device, measured in candela (cd).

3.6 FLASH DURATION – The light pulse duration, as measured between the 10% of peak amplitude for the leading and trailing edges of the light wave envelope in seconds.

3.7 INFORMATIVE – Textual, visual signaling controlled by fire alarm or other emergency signaling system equipment, or both.

3.8 LUMINANCE – The luminous intensity per unit area, measured in candela per square meter.

3.9 EMERGENCY WARNING – A system used to provide information and instructions to people in a building, area, site, or other space using intelligible voice communications methods. A Emergency warning system is used to notify occupants that an emergency exists.

3.10 PUBLIC MODE – Mode of operation intended to notify occupants or inhabitants in the area protected by the fire-alarm and signaling system.

3.11 PRIVATE MODE – Mode of operation intended to notify only those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fire-alarm and signaling system.

3.12 REFERENCE AXIS – The “reference point” of a visible signaling device is a point on the outside of the visible signal device in line with the geometrical center of the light source projected perpendicular to a plane passing through the edge of the light source.

3.13 REFERENCE POINT – The “reference axis” of a visible signaling device is a line passing through the reference point coincident with the geometrical axis of the light propagation pattern. For symmetrical structures, the reference axis is usually perpendicular to a plane passing through the edge of the light source.

3.14 RESONANCE – Condition of peak vibratory response where a small change in excitation frequency causes a decrease in system response.

3.15 SPECIAL TOOL – A device not normally carried by the public (e.g. a key), normally provided by the manufacturer.

Note: This is intended to deter unauthorized access to the equipment, while being available on site either at a defined location or from a “responsible person” familiar with and having knowledge of the equipment.

4 Instructions and Drawings

Note: In Canada, there are two official languages, French and English. Attention is drawn to the fact that some Canadian authorities may require instructions to be in both official languages. Refer to Annex C and Annex D.

4.1 Visible signal devices packaged individually shall include installation instructions and drawings as specified in 4.2 – 4.4 with each unit. Where devices are packaged in bulk (multiple devices in one single package) and not intended for individual resale, a minimum of one set of installation instructions and drawings shall be provided.

4.2 Installation drawings shall include the following items:

- a) Typical location, mounting, and orientation of units;
- b) The values of light output at various viewing angles with regard to product orientation, adjustment, and alignment, as measured in 7.3, Measurement of effective luminous intensity (light output);

Exception: This requirement does not apply to 7.3.7, informative textual displays.

- c) Flash rate;
- d) The effects of each specific accessory on the light output of the visible signal device;
- e) The effects of interchangeable lenses on the Effective Light Output of the device;
- f) Informative type visible signaling devices shall state intended mounting height above the finished floor and intended viewing distance.

4.3 Installation wiring drawings shall include the following items:

- a) Wire gauge related to circuit voltage and power rating;
- b) Wiring method which shall be in accordance with:
 - 1) In Canada, CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, Section 32;
 - 2) In the United States, the National Electrical Code, NFPA 70, and the National Fire Alarm and signaling Code, NFPA 72;
- c) Wire connections to the visible signal device, including equipment grounding by wire color code and identified terminals as applicable.

4.4 Instructions shall include a statement to caution against changing factory applied finishes.

4.5 The information required by 4.2 – 4.4 may be incorporated on the visible signaling device if it is visible after installation. Alternatively it may be incorporated inside of the visible signaling device if it is visible by opening the enclosure cover or by the removal of only field installed fasteners.

5 Construction

5.1 General

5.1.1 The construction of a visible signaling device shall comply with the construction requirements contained in this section, unless, where permitted by test, the construction is determined to be equivalent to these requirements.

5.1.2 Unless specifically indicated otherwise, the construction requirements specified for a product also apply to any accessories with which it is to be employed.

5.2 Enclosures

5.2.1 General

5.2.1.1 The frame and enclosure of a visible signaling device shall be sufficiently strong and rigid to resist the abuses to which it is likely to be subjected without adversely affecting its performance due to total or partial collapse with attendant reduction of spacings, loosening or displacement of parts and development of other conditions which could impair operation of the visible signaling device and increase the risk of fire or electrical shock. (Refer to Mechanical strength tests for enclosures, 7.20.)

5.2.1.2 Electrical parts or hazardous moving parts of a visible signaling device shall be located or enclosed to provide protection from unintentional contact with uninsulated live parts.

5.2.1.3 A visible signaling device intended to be installed on an outlet box or similar mounting enclosure, is to be judged with respect to compliance of the combination with the requirements of 5.2.1.1 and 5.2.1.2.

5.2.1.4 An operating part, such as a gear mechanism, light-duty relay, or similar device, shall be protected against mechanical damage and fouling by dust or other material which impairs its intended operation.

5.2.1.5 The enclosure of a device shall be provided with means for mounting in the intended manner. Any fittings, such as brackets, hangers, or similar hardware required for mounting shall be furnished with the device.

5.2.1.6 An enclosure shall have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable. Space shall be provided within a terminal or wiring compartment to permit the use of a standard conduit bushing on conduit connected to the compartment when a bushing is required for installation. An enclosure without such provision is permitted when:

- a) It is furnished with definite instructions indicating the sections of the enclosure which are intended to be drilled in the field for the connection of raceways, or
- b) The device is intended for mounting on a standard outlet box that is listed or approved for the intended use.

5.2.1.7 A visible signaling device intended for either flush or surface mounting in a back box shall use a standard enclosure that is approved for the intended use or an enclosure which complies with the requirements of this standard.

5.2.1.8 A visible signaling device need not be furnished with a back box where means for attachment to a standard outlet box are provided and the spacings comply with 5.8, Spacings.

5.2.1.9 The mounting means of a visible signaling device to an enclosure shall be accessible without disassembly of any components not identified in the installation instructions of the visible signaling device. The mounting means shall be independent of those means used for securing components or parts of the assembly. Removal of a complete assembly is not considered to be disassembly of a component.

5.2.1.10 **(REV1)** An enclosure shall be constructed to minimize the possibility of emission of flame, molten metal, flaming or glowing particles, or flaming drops. See Abnormal operation and burnout test, 7.10A.

5.2.1.11 A visible signaling device of less than 23 kg (50.7 lb) mass may be arranged for mounting to an outlet box provided that, if the product mass is more than 11 kg, it is plainly marked as specified in 6.3.

5.2.1.12 A visible signaling device of more than 23 kg (50.7 lb) mass shall incorporate space or a compartment for field wiring and shall be provided with means for mounting other than an outlet box.

5.2.2 Openings

5.2.2.1 Openings in the top of the enclosure shall be so constructed and shall be of such size that the entry of foreign objects is prevented.

5.2.2.2 To ensure compliance with 5.2.2.1, openings directly over uninsulated live parts or operating parts shall not exceed 5 mm (0.20 inch) in any dimension unless the configuration of the opening prevents entry of foreign objects. See Figure 1, Cross-sections of top cover designs, for examples of acceptable top cover designs.

5.2.2.3 Openings in the sides of the enclosure shall be so constructed and shall be of such size that the entry of foreign objects, or contact by service personnel, is prevented. Louvers are acceptable if shaped to deflect external falling objects outward. See Figure 2, Cross-sections of louver designs, for examples of acceptable louver designs.

5.2.2.4 **(REV1)** Openings in the bottom of enclosures under materials that do not have a flammability rating of V-1, may be permitted if constructed so that dropping through of material from the enclosure would be prevented.

The flammability rating shall be determined by the Flammability Classification Test:

- a) In Canada, CSA C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials;
- b) In the United States, Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C

Figure 3, Cross-sections of baffle design, illustrates a type of baffle that meets this requirement. A second acceptable construction is a nominal 1 mm thick sheet steel bottom panel in which 2 mm diameter round holes are spaced no closer than 1.5 times the hole diameter, centre to centre. Other constructions are acceptable if the visible signaling device complies with Abnormal operation and burnout test, 7.10A.

5.2.2.5 The bottom of an enclosure under materials that have a flammability rating of V-1 or better, may have openings not larger in area than 40 mm^2 (0.062 in^2).

5.2.2.6 An enclosure intended for recessed or semi-recessed mounting and having a front panel intended to be flush with the surface of the wall shall have no openings that vent into concealed spaces of a building structure, such as into hollow spaces in the wall, when the product is mounted as intended.

5.2.2.7 The requirement in 5.2.2.6 does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) if:

- a) No such opening has a dimension greater than 7 mm (0.275 in) or an area greater than 36 mm^2 (0.056 in^2);
- b) There is no more than one unused mounting screw hole for each 300 mm (11.8 in) of length of mounting surface, or fraction thereof, and
- c) An opening for mounting does not have a dimension of greater than 19 mm (3/4 in) or an area greater than 430 mm^2 (0.667 in^2) or there are no more holes than needed for mounting of the product.

5.2.2.8 Enclosure openings which are exposed after installation shall not permit entrance of a 19 mm (3/4 in) diameter rod and shall be of such size and so arranged that a probe, as illustrated in Figure 4, Accessibility probe, cannot be made to contact any uninsulated live electrical part, other than extra low-voltage, when inserted through the opening in a straight or articulated position.

5.2.2.9 Notwithstanding the requirement of 5.2.2.8, enclosure openings which are exposed after installation shall be sized and so arranged that a straight rod of circular cross section 6.4 mm (0.25 in) diameter with a hemispherical end cannot be made to contact any uninsulated live part and cannot damage any part of the visible signaling device by a push force of 4.5 N (1 lb-f) so as to impair operation, reduce electrical spacings or otherwise reduce the reliability of the visible signaling device.

5.2.2.10 Openings for a vandal-resistant visible signaling device (see also Marking, 6) shall not provide direct access to any light-producing element by a rigid rod 0.8 mm (0.03 in) in diameter.

5.2.2.11 Openings in an enclosure, that are required for the proper visible performance of an appliance (including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or perforated covers) and provide access to the light-producing element, shall be of such size or shape that no opening will permit passage of a rod having a diameter of 6.7 mm (17/64 in).

5.2.2.12 With reference to 5.2.2.11, the wires of a screen shall be not less than 16 AWG (1.3 mm^2). Except as noted in 5.2.2.13 perforated sheet steel and sheet steel employed for expanded-metal mesh shall be not less than 1.07 mm (0.042 in) in average thickness, 1.17 mm (0.046 in) if zinc coated.

5.2.2.13 Expanded-metal mesh, 0.53 mm (0.021 in) thick or 0.61 mm (0.024 in) thick if zinc-coated, may be used when all of the following conditions are met:

- a) The mesh openings are not more than 1.6 cm^2 ($1/4 \text{ in}^2$) in area,
- b) The maximum dimension of the overall opening so protected is not greater than 76.2 mm (3 in), and

- c) Indentation of the guard or enclosure does not impair performance or reduce spacings below the required values as given in 5.8, Spacings, between uninsulated live parts, or between uninsulated movable parts.

5.2.3 Cast metal enclosures

5.2.3.1 The thickness of cast metal for an enclosure shall be as indicated in Table 1, Cast metal enclosures.

Exception: Cast metal of lesser thickness may be employed if, consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See Mechanical strength tests for enclosures, 7.20.

5.2.3.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, there shall be not less than 3.5 or more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing can be properly attached.

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

5.2.3.4 A visible signaling device assembly designed to be supported by rigid conduit shall be of sufficient strength to be able to support 5 times the weight of the visible signaling device assembly and comply with Mechanical strength tests for enclosures, 7.20. When provided with a conduit hub, or the equivalent, the hub shall have not less than 5 full threads.

5.2.3.5 Die-cast metal for other than flush boxes is permitted when it complies with one of the alloy specifications given in Specifications for Zinc-Alloy Die Castings, ANSI/ASTM B86-98.

5.2.3.6 Compliance of a zinc-base alloy die casting with the requirement of 5.2.3.5 is to be determined by the Standard Method of Spectrochemical Analysis of Zinc-Base Alloys and High-Grade Zinc by the Solution Residue-DC Arc Technique, ASTM E27-81.

5.2.4 Sheet metal enclosures

5.2.4.1 The thickness of sheet metal employed for the enclosure of a visible signaling device shall be not less than that indicated in Table 2, Minimum thickness of sheet metal.

Exception: Sheet metal of lesser thickness may be employed if, consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See Mechanical strength tests for enclosures, 7.20.

5.2.4.2 A plate or plug closure for an unused conduit opening or other hole in the enclosure shall have a thickness not less than:

- a) 0.36 mm (0.014 in) for steel or 0.43 mm (0.017 in) for nonferrous metal for a hole having a 6.4 mm (1/4 in) maximum dimension; and
- b) 0.69 mm (0.027 in) for steel or 0.81 mm (0.032 in) for nonferrous metal for a hole having a 35 mm (1-3/8 in) maximum dimension.

5.2.4.3 A hole larger than 35 mm (1-3/8 in) diameter shall have a closure whose thickness is not less than that required for the enclosure of the product or shall have a standard knockout seal. Such plates or plugs shall be securely mounted.

5.2.4.4 A knockout in a sheet metal enclosure shall be secured but shall be capable of being removed without undue deformation of the enclosure. See Mechanical strength tests for enclosures, 7.20.

5.2.4.5 A knockout shall be provided with a surrounding surface area of sufficient size to permit seating of a conduit bushing, and shall be located so that a bushing employed at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those indicated under Spacings, 5.8.

5.2.4.6 A sheet metal member to which a wiring system is to be connected in the field shall have a thickness not less than 0.81 mm (0.032 in) for uncoated steel, not less than 0.86 mm (0.040 in) for galvanized steel, and not less than 1.14 mm (0.045 in) for nonferrous metal.

5.2.4.7 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 has a stiffness at least equivalent to that of an uncoated flat steel sheet having a minimum thickness of 1.35 mm (0.053 in).

5.2.4.8 An enclosure intended for recessed mounting shall have no nonfunctional openings on any of the enclosed sides.

5.2.5 Nonmetallic enclosures

5.2.5.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be so formed that operating parts will be 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 2.

5.2.5.2 The continuity of any grounding system to which an appliance is capable of being connected shall not rely on the dimensional integrity of the nonmetallic material.

5.2.5.3 Among the factors taken into consideration when judging the acceptability of a nonmetallic enclosure are the following:

- a) The mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Flammability and resistance to ignition from electrical sources;
- e) Dielectric strength, insulation resistance, and resistance to arc tracking; and
- f) Resistance to distortion and creeping at temperatures to which the material may be subjected.

Note: All these factors are considered with respect to ageing in accordance with the Tests on polymeric (plastic) materials, 7.19.

5.2.6 Enclosure cover

5.2.6.1 An enclosure cover shall be secured against opening or removal by means requiring the use of a common or special tool. A decorative cover or trim that, if removed, does not expose live electrical or mechanical parts is exempt from this requirement.

5.2.7 Transparent covers

5.2.7.1 Glass covering an observation opening shall:

- a) Be tempered or similarly treated material to minimize potential injuries;
- b) Be secured in place so that it cannot be displaced in service; and
- c) Provide mechanical protection for the enclosed parts.

5.2.7.2 The thickness of a glass cover shall not be less than that indicated in Table 3, Thickness of glass covers.

5.2.7.3 A glass panel for an opening having an area of more than 929 cm² (144 in²), or having any dimension greater than 305 mm (1 ft), shall be supported by a continuous groove not less than 4.8 mm (0.19 in) deep along all four edges of the panel, or by an arrangement that has been determined to be equivalent.

5.2.7.4 A transparent material other than glass shall not be used for the cover of an observation opening unless the material does not introduce a risk of fire, distort, or become less transparent when subjected to varying temperatures under either normal or abnormal service conditions.

5.2.8 Outdoor use enclosures

5.2.8.1 The enclosure of a visible signaling device intended for outdoor use shall incorporate the following:

- a) Means for mounting designed to prevent water from entering the enclosure. See Water Spray, 7.16;
- b) Holes for conduit shall be threaded unless they are located below the lowest termination point or other live part within the enclosure. If knockouts or unthreaded holes are provided, there shall be provision for drainage of the enclosure; and
- c) A gasket shall be of material which will resist moisture and shall be cemented, pinned, or otherwise secured to one of the contacting surfaces.

5.2.8.2 A surface mount enclosure intended for outdoor use shall be provided with external means for mounting.

Exception: Internal means for mounting may be employed if constructed so as to prevent water from entering the enclosure.

5.2.8.3 For outdoor use, an enclosure of sheet steel less than 3.04 mm (0.12 in) in thickness, 3.18 mm (0.125 in) or less if zinc coated, shall be galvanized by the hot-dip process after forming and assembly, or shall be made from hot-dipped sheets, or shall be provided with a coating which is at least the equivalent, with respect to corrosion protection, of zinc applied by the hot-dip process.

5.3 Corrosion protection

5.3.1 Ferrous metal, iron and steel parts other than bearings and similar parts where such protection is impractical, shall be protected against corrosion by enamelling, galvanizing, plating, or other equivalent means. Refer to Accelerated corrosion tests, 7.15.

Exception No. 1: This requirement does not apply to parts such as washers, screws, bolts, and the like, if failure of such unprotected parts would not be likely to result in a risk of fire or electrical shock, or affect the performance of the visible signaling device.

Exception No. 2: Parts made of stainless steel, polished or treated, do not require additional protection against corrosion.

5.3.2 The requirement of 5.3.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

5.3.3 Bearing surfaces shall be of such materials and design as to resist binding due to corrosion.

5.3.4 Metals shall not be used in combinations such as to cause galvanic action. Refer to Accelerated corrosion tests, 7.15.

5.3.5 Cabinets and enclosures of corrosion-resistant material may be employed without special corrosion protection.

5.4 Field wiring connections

5.4.1 General

5.4.1.1 Wiring terminals or leads corresponding to the rating of the device shall be provided for connection of conductors of at least the size required by:

a) In Canada, CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, Section 32;

B In the United States, the National Electrical Code, NFPA 70.

5.4.1.2 Wiring terminals shall be prevented from turning.

5.4.1.3 The terminals to which wiring connections are made shall consist of binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position. Other terminal connections may be provided if found to be equivalent

5.4.1.4 Dual terminals, dual leads, or equivalent means to achieve electrical supervision, shall be provided for each incoming and each outgoing circuit connection. A common terminal may be used for connection of both incoming and outgoing wires, provided that the construction of the terminal does not permit an uninsulated section of a single conductor to be looped around the terminal and serve as two separate connections, thereby precluding supervision of the connection in the event that the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw, where separate conductors of a notification appliance (signaling device) circuit are intended to be inserted in each notch, is acceptable, but this arrangement shall be supplemented by additional marking in the wiring area or on the installation wiring diagram specifying the intended connections to the terminals.

5.4.2 Field wiring compartment

5.4.2.1 The field wiring compartment in which connections are made shall be of sufficient size for accommodating all wiring connections specified by the installation wiring drawing without damage to wire insulation or to internal components. 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.

5.4.2.2 The device wiring and internal components in the wiring area of a visible signaling device designed for mounting to an outlet box shall be so located or protected so that, they and the field wiring in the outlet box are not forced against sharp edges, to prevent damage.

5.4.2.3 An outlet box or compartment in which field wiring connections are to be made shall be located such that the connections may be inspected after the visible signaling device is installed as intended. The removal of only field installed fasteners, or equivalent arrangement, and the dismounting of an assembly, of not more than 4.5 kg mass to view the field wiring connections, is deemed to comply with this requirement.

5.4.2.4 A visible signaling device without a field wiring compartment shall be constructed so that the following requirements are met:

- a) Field wiring and leads shall be prevented from contacting moving parts of the visible signaling device when such contact would result in damage to the wire insulation or interfere with the operation of the product;
- b) Field wiring and leads shall be prevented from contacting parts of the visible signaling device, which under any condition of operation may achieve a temperature exceeding the temperature rating of the wire or lead insulation. Refer to Temperature rise, 7.5; and
- c) Field wiring and leads shall be prevented from contacting uninsulated live parts which under any condition of operation may be at a potential exceeding the voltage rating of the wire or lead insulation. Refer to Separation of circuits, 5.5.2, and Spacings, 5.8.

5.4.3 Field wiring terminals and leads

5.4.3.1 Types and sizes

5.4.3.1.1 Terminals for field connection of conductors larger than 10 AWG (5.3 mm²) shall consist of nonferrous soldering lugs or nonferrous solderless (pressure) wire connectors.

5.4.3.1.2 Terminals for field connection of conductors 10 AWG (5.3 mm²) or smaller may consist of means for clamping the conductor if such means are constructed so that:

- a) They will firmly grip the conductors and securely hold them in place; and
- b) Solid conductors cannot come out from under the clamping means even though the latter is loosened sufficiently to allow lateral movement of the conductors with respect to the means.

5.4.3.2 Size of screws

5.4.3.2.1 If binding head screws or machine screws and washers are used as clamping means for conductors, the size of screw shall be not less than:

- a) No. 8 or M4 if for use with conductors 14 AWG (2.1 mm²) or larger;
- b) No. 6 or M3.5 if for use with conductors 14 AWG (2.1 mm²) or smaller and 18 AWG (0.82 mm²) or larger; or
- c) M3, if for use with conductors 18 AWG (0.82 mm²).

5.4.3.3 Material for terminal parts

5.4.3.3.1 Binding head screws, bolts, studs, nuts and washers shall be of nonferrous metal except that in sizes No. 10 M5 or larger, iron or steel may be used if:

- a) Such parts are suitably protected with a plating of cadmium, zinc, or equivalent material; and
- b) The conductor or terminal to be secured is clamped against a surface of nonferrous metal which will carry the greater part of the current.

5.4.3.4 Terminal plates and threading

5.4.3.4.1 Wiring terminal screws shall thread into metal.

5.4.3.4.2 Threading of binding head screws and machine screws, other than wiring terminal screws, into material other than metal are not prohibited from being used when determined to be equivalent in terms of mechanical secureness and conductivity.

5.4.3.4.3 Terminal plates through which binding head screws or machine screws are threaded shall have a thickness at least equal to twice the pitch of the thread of the screw, but not less than 0.762 mm (0.030 in), and shall have at least two complete clean-cut full threads.

5.4.3.4.4 Terminal plates for solderless connectors or solderless lugs shall:

- a) Have a thickness of not less than 1.27 mm (0.050 in) for a No. 8, M4 or larger screw, and not less than 0.76 mm (0.030 in) thick for a No. 6 M3.5 screw;
- b) Have at least two complete full threads, if threaded; and may have the metal extruded at the tapped hole for the binding screw so as to provide two full threads; and
- c) Provide contact areas, such that the full contact area of the tongue of the largest lug which would normally be used will be properly utilized.

5.4.3.4.5 Screws engaging threaded holes in plates shall have not less than two full threads engaging under any condition of service.

5.4.3.4.6 If terminal screws do not pass entirely through threaded holes, they shall engage clean-cut full threads for a distance not less than the major diameter of the screw.

5.4.3.5 Grounding terminals and leads

5.4.3.5.1 For an appliance intended for connection to an AC Mains source of supply, only by means of other than a metal-enclosed wiring system such as nonmetallic-sheathed cable, all of the following shall be provided:

- a) An equipment grounding terminal or lead, the size of which shall be the same as that of the supply terminal or lead, but in no case less than 18 AWG (0.82 mm²),
- b) A marking to indicate the system or systems for which it is intended, and
- c) Reliable connection of the grounding means to all exposed dead metal parts that are likely to become energized, and all dead metal parts within the enclosure that are exposed to contact during servicing and maintenance.

5.4.3.5.2 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. No other leads visible to the installer, other than the grounding conductors, shall be so identified.

5.4.3.5.3 A field wiring terminal intended for connection of an equipment grounding conductor shall be plainly identified, with the marking G, GR, GROUND, GROUNDING, by the graphic symbol 5019 from IEC publication 60417-1, ⊕, or the equivalent, or by a marking on a wiring diagram provided on the appliance. The field wiring terminal shall be located so that it is unlikely to be removed during servicing of the appliance.

5.4.3.6 Grounded supply terminals and leads

5.4.3.6.1 A field wiring terminal for the connection of the grounded supply conductor of a AC Mains supply circuit shall be identified by means of a white metallic-plated coating and shall be distinguishable from the other terminals. Otherwise, identification of the terminal for the connection of the grounded conductor shall be shown in some other manner, such as on an attached connection diagram.

5.4.3.6.2 A field wiring lead provided for connection of the grounded supply conductor of a AC Mains supply circuit shall be finished white or gray and shall be distinguishable from other leads. No other leads visible to the installer, other than grounded conductors, shall be so identified.

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

5.4.3.6.4 Terminals which are intended for direct connection to either a grounded conductor or a neutral conductor of a supply circuit shall be identified. They shall be substantially white in colour if colour coded, or be marked "N" or "Neutral", or "W" or "White", either on or adjacent to the terminal.

5.4.3.7 Field wiring leads

5.4.3.7.1 Leads provided for field connections shall be:

- a) Stranded copper bunch tinned in accordance with
 - i) In Canada, CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, Rule 32-100
 - ii) In the United States, the National Electrical Code, NFPA 70;
- b) Not less than 150 mm (6 in) in length;
- c) Not smaller than 18 AWG (0.82 mm²);
- d) The insulation, if of rubber or plastic, not less than 0.8 mm (0.032 in) in thickness; and
- e) Provided with strain relief so as to be capable of withstanding for 1 min a pull of 45 N without any evidence of damage or of transmitting the stress to internal connections. (Refer to Strain relief 7.14.

5.4.3.7.2 Leads which are intended for direct connection to either a grounded conductor or a neutral conductor of a supply circuit shall be identified at the point of supply connection. Identification shall be a white or natural gray covering readily distinguishable from the finish on other leads and no other lead shall be so identified.

5.5 Internal wiring

5.5.1 General

5.5.1.1 Wiring shall have insulation rated for the potential involved and the temperatures to which it may be subjected, and shall have adequate mechanical strength and current-carrying capacity for all conditions of service. The wiring shall be routed away from moving parts and sharp projections and held in place with clamps, string, ties, or the equivalent, unless the wiring is capable of retaining a shaped form.

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

5.5.1.3 If the use of a short length of insulated conductor (for example a short coil lead) is not feasible, electrical insulating tubing complying with CSA 22.2 No. 198.1, Extruded Insulating Tubing, or the Standard for Extruded Insulating Tubing, UL 224, may 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.

5.5.1.4 Insulation, such as coated fabric and extruded tubing, shall not be affected physically or electrically by the temperature or other environmental conditions to which the insulation may be subjected to during the intended use of the visible signaling device.

5.5.1.5 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like, which may cause abrasion of the conductor insulation.

5.5.1.6 All splices and connections shall be mechanically secure and bonded electrically.

5.5.1.7 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands bunch-tinned or equivalently arranged.

5.5.1.8 A splice shall be provided with insulation equivalent to that of the wires involved.

5.5.1.9 A splice shall be located, enclosed, and supported so that it is not subject to damage from flexing, motion, or vibration.



5.5.2 Separation of circuits

5.5.2.1 Internal wiring of circuits which operate at different potentials shall be separated by barriers, clamps, routing, spacing (refer to Table 4, Minimum spacings), or other equivalent means, unless all conductors are provided with insulation rated for the highest potential involved.

5.5.2.2 A metal barrier used to provide separation between the wiring of different circuits shall have a thickness at least equal to that required by Table 2, Minimum thickness of sheet metal, as determined by the size (width and length) of the barrier. A barrier of insulation material shall be not less than 0.71 mm (0.028 in) in thickness and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1.6 mm (0.063 in).

5.6 Bonding for grounding

5.6.1 An exposed dead metal part that could become energized shall be bonded to the point of connection of the equipment grounding terminal or lead and to the metal surrounding the knockout, hole, or bushing provided for field power-supply connections.

Exception No. 1: An adhesive-attached metal-foil marking, screw, handle, or similar material is not required to be bonded when located on the outside of an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts so that it is not likely to become energized.

Exception No. 2: An isolated metal part, such as a motor-controller magnet frame or armature or a small assembly screw, is not required to be bonded when positively separated from wiring and uninsulated live parts.

Exception No. 3: A panel or cover that does not enclose uninsulated live parts is not required to be bonded when wiring is separated from the panel or cover so that it will not become energized.

Exception No. 4: A panel or cover is not required to be bonded when it is 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.

5.6.2 An uninsulated dead metal part of a cabinet, electrical enclosure, motor-frame or mounting bracket, controller mounting bracket, capacitor or other electrical components, shall be bonded for grounding if it may be contacted by the user or by service personnel servicing the equipment.

5.6.3 A bonding means shall be an acceptable electrical conductor. If of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent. The conductor shall be of acceptable size. A separate bonding conductor shall be installed so that it is protected from mechanical damage.

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

5.6.5 A bolted or screwed connection that incorporates a star washer or serrations under the screwhead is acceptable for penetrating nonconductive coatings where required for compliance with 5.6.1.

5.6.6 When the bonding means depends upon screw threads, the use of two or more screws or two full threads of a single screw engaging metal shall comply with 5.6.1.

5.6.7 A metal-to-metal hinge-bearing member of a door or cover is acceptable as a means for bonding the door or cover for grounding, provided that a multiple bearing-pin type (piano-type) hinge is employed.

5.6.8 The size of a copper or aluminum conductor employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch-circuit overcurrent device by which the appliance will be protected. The size of the conductor shall be in accordance with Table 5, Bonding wire conductor size.

5.6.9 A conductor, such as a clamp or strap, may be used in place of a separate wire conductor, provided that the minimum cross-sectional conducting area of the bonding means is not less than that of the wire indicated in Table 5, Bonding wire conductor size.

5.6.10 A splice shall not be employed in a wire conductor used for bonding.

5.6.11 The grounding means shall be used for no other purpose.

5.7 Components – Electrical

5.7.1 Mounting of components

5.7.1.1 All stationary parts of a visible signaling device, which support moving components, shall be securely mounted in position and prevented from loosening or turning.

5.7.1.2 Un-insulated live parts shall be so secured to the base or mounting surface that they will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum values required. Refer to Spacings, 5.8.

5.7.1.3 Friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part as required in 5.7.1.1 and 5.7.1.2, but a toothed lock washer that provides both spring take-up and an interference lock or equivalent means is acceptable.

5.7.1.4 An un-insulated live part, such as a field wiring terminal, shall be secured to its supporting surface or surfaces by methods other than friction between surfaces if turning or shifting in position may result in a reduction of spacings below the minimum values required. The part shall be secured 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 some other equivalent method.

5.7.2 Insulating materials

5.7.2.1 Materials used for the support of current-carrying parts shall be nonflammable, moisture-resistant insulating material, such as porcelain, phenolic or cold-molded composition, or the equivalent.

5.7.2.2 Among the factors to be considered in judging electrical insulation are mechanical and electrical strength, resistance to burning, moisture, arcing, creep (flow due to stress), thermal endurance and resistance to temperatures encountered in intended use.

5.7.2.3 A terminal block mounted on a metal surface that may be 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 secured to prevent movement of the parts at the ends of replaceable terminal screws from reducing spacings below the minimum values required.

5.7.2.4 Ordinary vulcanized fibre may be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts where shrinkage, current leakage, or warping of the fibre may introduce a risk of fire or electric shock.

5.7.2.5 Polymeric materials may be used for the sole support of uninsulated live parts if found to be equivalent to the materials indicated in 5.7.2.4.

5.7.2.6 A countersunk sealed live part shall be covered with a waterproof insulating compound which will not melt at a temperature 15°C (59 °F) higher than the maximum normal operating temperature of the assembly, and at not less than 65°C (149°F) in any case. The depth or thickness of sealing compound shall be not less than 3.2 mm (1/8 in).

5.7.2.7 The thickness of a flat sheet of insulating material, such as impregnated asbestos-cement composition or phenolic composition employed for panel mounting of parts shall be not less than that specified in Table 6, Thickness of flat sheets of insulating material.

5.7.3 Current-carrying parts

5.7.3.1 A current-carrying part shall be of silver, copper, a copper alloy, or the equivalent.

5.7.3.2 Bearings, hinges, or similar parts are not acceptable for carrying current between interrelated fixed and moving parts.

5.7.3.3 Plated steel shall not be used for secondary-circuit parts nor for primary-circuit parts, such as capacitor terminals, unless a glass-to-metal seal is necessary, nor for leads or threaded studs of semiconductor devices. Blued steel or steel with corrosion resistance that has been determined to be equivalent is acceptable for the following:

- a) The current-carrying arms of mechanically- or magnetically-operated leaf switches;
- b) Within a motor and motor governor, including the motor terminals; or
- c) When the temperatures exceed 100°C (212°F) during the intended operation.

5.7.4 Bushings

5.7.4.1 Where a lead or wire harness passes through an opening in a wall, barrier, or enclosing case, there shall be a metal or insulating bushing, or the equivalent, that shall be secured in place and have a smooth rounded surface against which the wire may bear.

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

5.7.4.3 Ceramic materials and some molded compositions are permitted for insulating bushings, but separate bushings of wood and of hot-molded shellac are not permitted.

5.7.4.4 A fiber bushing may be used if:

- a) It will not be subjected to a temperature higher than 90°C (194°F) under intended operating conditions,
- b) The bushing is not less than 1.2 mm (3/64 in) thick, and
- c) The fiber will not be exposed to moisture.

5.7.4.5 Ordinary vulcanized fibre may be employed where it will not be subjected to a temperature higher than 90°C (194°F) under intended operating conditions if the bushing is not less than 1.2 mm (3/64 in) in thickness and if it will not be exposed to moisture.

5.7.4.6 A soft rubber bushing may be employed in the frame of a motor if the bushing is not less than 1.2 mm (3/64 in) in thickness and if the bushing is so located that it will not be exposed to oil, grease, oily vapor, or other substances which may have a deleterious effect on rubber. If a soft rubber bushing is employed in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, which could cut into the rubber.

5.7.4.7 An insulating-metal grommet is acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 0.8 mm (0.032 in) in thickness and completely fills the space between the grommet and the metal in which it is mounted.



5.7.5 Semiconductors

5.7.5.1 Semiconductors shall be rated for the intended application under all environmental conditions to which they may be exposed in service. Refer to Performance Tests, Section 7.

5.7.6 Transformers, relays, and coils

5.7.6.1 Coils shall be treated with an insulating varnish, and baked or otherwise impregnated to exclude moisture.

5.7.6.2 Film coated, or equivalently coated wire is not required to be given additional treatment to prevent moisture absorption.

5.7.7 Capacitors

5.7.7.1 Capacitors shall be rated for the intended application under all environmental conditions to which they may be exposed in service.

5.7.7.2 Capacitors shall be suitable for the purpose. There shall be no failure of the capacitors when the product is subjected to 7.5, Temperature rise, and 7.7, Endurance. The measured peak voltage across the capacitor shall not exceed the voltage stress level as specified in 7.11, Component stress.

5.7.8 Operating parts

5.7.8.1 Operating parts of a visible signaling device appliance shall be located or protected so that their function is not impaired by any wiring operation within the enclosure.

5.7.8.2 A cam or similar part shall be mechanically fastened so that independent turning or loosening is prevented.

5.7.8.3 An operating component or assembly, such as a switch or relay, shall be protected by an individual cover or dust-tight cabinet against fouling by dust or by other material that may impair its operation.

5.7.8.4 A moving part shall have sufficient play at bearing surfaces to prevent binding.

5.7.8.5 An adjusting screw or similar adjustable part shall be prevented from loosening under the conditions of actual use.

5.7.8.6 A manually operated part shall withstand the stresses to which it is subjected to in operation.

5.7.8.7 Interrelated operating parts shall be formed and assembled so that their alignment is maintained.

5.7.8.8 Gears shall have uniformly formed teeth with smooth engaging surfaces, and shall be reliably secured in place.

5.7.8.9 The assembly of an operating mechanism included as a part of a product shall be such that it will not be adversely affected by any condition of intended operation.

5.7.9 Connectors and receptacles

5.7.9.1 A receptacle or connector shall be rated for the current and voltage to which it is subjected.

5.7.10 Printed wiring boards

5.7.10.1 Printed wiring boards shall comply with the Standard for Printed Wiring Boards, UL 796. The components of a printed wiring board shall be attached securely and the spacings between circuits shall comply with the spacing requirements for rigidly clamped assemblies (see Table 4, Minimum spacings). The board shall be mounted so that deflection of the board during servicing shall not result in damage to the board or in a reduction of electrical spacings to less than those required in this standard. A printed-wiring board shall have a minimum flammability rating of V-2, be rated for direct support of current-carrying parts, and be suitable for the soldering process used.

5.7.11 Motors

5.7.11.1 A motor shall be protected against overheating under normal and abnormal operating conditions.

5.7.11.2 A motor shall be protected by thermal or overcurrent protective devices or shall be of the impedance-protected type. See the Locked rotor test, 7.25. A thermal or overcurrent protective device shall not open the circuit during the Temperature rise, 7.5.

5.7.11.3 A motor having openings in the enclosure or frame shall be arranged so that flaming or glowing particles dropping out of the motor will not fall onto flammable material within or under the visible signaling device.

5.8 Spacings

5.8.1 Spacings between uninsulated live parts, between uninsulated live parts and dead metal parts, and between uninsulated live parts of opposite polarity shall be not less than those indicated in Table 4, Minimum spacings.

Exception No. 1: The spacing requirements in Table 4, Minimum spacings, do not apply to the inherent spacings of a component which is provided as part of the unit. 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 4, Minimum spacings.

Exception No. 2: The "To Walls Of Enclosure" spacings indicated in Table 4, Minimum spacings, are not to be applied to an individual enclosure of a component part within an outer enclosure.

5.8.2 The spacings between an un-insulated live part and a wall or cover of a metal enclosure, a fitting for conduit or metal-clad cable, and a metal piece attached to a metal enclosure where deformation of the enclosure is liable to reduce spacings, shall be not less than those indicated in Table 4, Minimum spacings.

5.8.3 The “Through Air” and “Over Surface” spacings at an individual component part are to be judged on the basis of the apparent power (VA) available to the individual component.

5.8.4 The spacing 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 VA available to the entire assembly.

5.8.5 Film coated wire is considered an un-insulated live part in determining compliance with spacing requirements, but is acceptable as turn-to-turn insulation in coils.

5.8.6 An insulating liner or barrier of vulcanized or impregnated fibre, varnished cloth, mica, phenolic composition, or similar material employed where spacings would otherwise be insufficient, shall be not less than 0.7 mm (0.028 in) in thickness, except that a liner or barrier not less than 0.3 mm (0.012 in) in thickness may be used in conjunction with an air spacing of not less than 50% of the “Through Air” spacing required. The liner shall be located so that it will not be subjected to the direct effects of arcing.

5.8.7 Insulating material having a thickness less than that specified in 5.8.5 may be used if it has equivalent mechanical and electrical properties.

5.8.8 When a short-circuit between uninsulated live parts of the same polarity would prevent the intended signaling operation of the product without simultaneously producing a trouble or abnormal signal, the spacings between such parts shall be at least the minimum applicable value specified for “Other parts” in Table 4, Minimum spacings.

6 Marking

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. Refer to Annex C and Annex D.

6.1 Each visible signaling device shall be legibly and permanently marked with the manufacturer’s or private labeler’s name, trademark, or other recognized symbol of identification. In addition, the Effective Light Output in candela or code shall be readily visible after installation. If field-installed colored lenses are to be used, the effective candela output or de-rating factor of the colored lens shall be readily visible after installation.

Exception: The requirement for effective light output does not apply to 7.3.7, informative textual displays.

6.2 **(REV1)** The following information shall be legibly and permanently marked on the device where it will be readily visible after installation, readily visible by opening the enclosure cover, (refer to Enclosure cover, 5.2.6) or readily visible by the removal of only the field installed fasteners:

- a) Model number or equivalent;
- b) Input ratings as follows:
 - 1) Voltage designation (regulated or special application);
 - 2) Voltage type (direct current, full wave rectified, alternating current);
 - 3) Voltage operating limits;

- 4) Series duty maximum open circuit voltages with the words “Series Duty” and/or “Service série” for units intended for series connection;
 - 5) Maximum operating current in amperes;
 - 6) Voltage, frequency;
 - 7) Horsepower rating shall be included in the case of a motor-operated appliance.
 - 8) Visual signals with pulse widths greater than 1 ms shall be marked with their pulse width.
- c) Correct mounting if the signaling device is intended to be mounted in a specific orientation. Where it is impractical to include this information on the device, reference shall be made to an installation mounting drawing by number and issue date;
- d) Reference to an installation wiring drawing, if not attached to the signaling device, by number and issue date or control number or revision level. See Instructions and Drawings, 4;
- e) A signaling device that produces a signal as long as its energizing circuit is closed although intended for intermittent duty only shall be marked to indicate its duty cycle; and
- f) Rating of fuse in each fuseholder when required to comply with the requirements in this standard. The marking shall be located in close proximity to the fuseholder.

6.3 The following information shall be legibly and permanently marked on the device but does not have to be readily visible after installation:

- a) Date of manufacture by week, month, or quarter and year (any of which may be abbreviated or presented in an established or otherwise traceable code or serial number);
- b) When devices are manufactured at more than one factory, each device shall have a distinctive marking to identify it as a product of a particular factory;
- c) A visible signaling device shall be marked for its intended installation environment (indoor or outdoor) and location dry (optional), damp, or wet. If the outdoor-use application requires the use of a specific back box, the marking shall include this information. Also refer to 7.16, Water spray;
- d) A visible signaling device with a mass of more than 11 kg (24-1/4 lb) shall be marked with the mass and an applicable warning statement informing the installer to use a support system which has load strength, to comply with the applicable codes and standards, as required in 5.2.1.11;
- e) A visible signaling device for fire alarm service that does not meet the requirements for public mode shall also be marked “Private Mode” and/or “Mode Prive”. A public mode appliance needs no additional marking;
- f) A visible signaling device intended for permanent connection only to a AC Mains supply other than a metal-enclosed system, shall be marked to indicate the system or systems for which it is intended. The marking shall be located so that it will be visible when power connections to the appliance are made;