

**STANDARD FOR MASS NOTIFICATION SYSTEM EQUIPMENT
AND ACCESSORIES**

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STANDARD FOR MASS NOTIFICATION SYSTEM EQUIPMENT AND ACCESSORIES

PREFACE

This is the First Edition of the Standard for Mass Notification System Equipment and accessories.

This Edition of the Standard has been formally approved by the ULC Standards Committee on Fire Alarm and Life Safety Equipment and Systems.

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.

Annexes A, B, & C identified as Informative, are for information purposes only.

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

Attention is drawn to the possibility that some of the elements of this 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 initiation of the review of this Standard will commence within 5 years of 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.

INTRODUCTION

1 SCOPE

1.1 These requirements cover discrete electrical control units, communication units, transport products which manipulate the data packets, interfaces, and accessories for mass notification systems.

1.2 The products covered by this standard are intended to be used in combination with other appliances and devices to form an *emergency communication and/or mass notification system*. These products are intended to communicate critical information within *buildings* and/or outdoor areas about emergencies including but not limited to terrorist activities, hazardous chemical releases, severe weather, fire, *Amber Alert*, and other situations that may endanger the safety of the occupants of an area or facility. Communication is through voice, audible, and/or visual instructions. An installation document(s) provided with the product describes the various products needed to form an *emergency communication and/or mass notification system* and their intended use and installation.

1.3 These requirements address emergency service personnel communication system interfaces used in the performance of their duties if that communication equipment is used to interface with or control the *Emergency Communication Systems/Mass Notification Systems (ECS/MNS)*.

1.4 Audible Signalling Devices are to be assessed to the Standard for Audible Signalling Devices for Fire Alarm and Signalling Systems, Including Accessories, ULC-S525, and the Standard for Speakers for Fire Alarm and Signalling Systems, Including Accessories, ULC-S541. Visible Signalling Devices are to be assessed to the Standard for Visible and Textual Signalling Devices for Fire Alarm Systems, Including Accessories, CAN/ULC S526.

1.5 Products incorporating fire and/or security signalling functions or other life safety systems shall comply with the ULC Standards, CSA Standards or other standards applicable to their intended function and application in addition to this standard.

1.6 *Mass notification system* equipment and installations shall comply with Industry Canada rules and regulations, as applicable, concerning the following:

- A Electromagnetic radiation;
- B Use of radio frequencies; and
- C Connection to the public switched telephone network of telephone equipment, systems, and protection apparatus.

2 GENERAL

2.1 COMPONENTS

2.1.1 Except as indicated in Clause 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

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

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

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

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

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.

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

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

2.3 REFERENCE PUBLICATIONS

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 the Committee approved this ULC Standard. All undated references shall be interpreted as referring to the latest edition of that document.

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

- ASTM B117-09, Standard Practice for Operating Salt Spray (Fog) Apparatus
- ASTM D396-02a, Standard Specification for Fuel Oils
- ASTM D1654-92 (R2000), Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- ASTM E11-09, Standard Specification for Wire Cloth and Sieves for Testing Purposes
- ASTM E230/E230M, Standard Specification and Temperature Electromotive (emf) Tables for Standardized Thermocouples

Standards Published by CSA Standards
5060 Spectrum Way, Mississauga, ON L4W 5N6 Canada
Telephone: (416) 747-4000 or 1-800-469-6727
www.csa.ca

- CAN/CSA 60065-03 (Amd1, 2006), Audio, Video, and Similar Electronic Apparatus — Safety Requirements
- CSA C22.1-06, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations
- CAN/CSA-C22.2 No. 0-M91 (R2003), General Requirements – Canadian Electrical Code, Part II
- CSA C22.2 No. 0.15-01, Adhesive Labels
- CAN/CSA-C22.2 No. 0.17-00, Evaluation of Properties of Polymeric Materials
- CSA C22.2 No. 65-03, Standard for Wire Connectors

- CAN/CSA-C22.2 No. 94-M91, Special Purpose Enclosures
 - CAN/CSA-C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non-Environmental Considerations
 - CAN/CSA-C22.2 No.94.2-07, Enclosures for Electrical Equipment, Environmental Considerations
 - CAN/CSA C22.2 No. 223, Power Supplies with Extra-Low-Voltage Class 2 Outputs
 - CAN/CSA C22.2 No. 226-92, Protectors in Telecommunication Networks
 - CAN/CSA C22.2 No. 60950-1-2007, Information Technology Equipment Safety — Part 1: General Requirements
 - CSA C22.2 No.107-01, General Use Power Supplies
 - CSA C22.2 No. 158-1987, Terminal Blocks
-

Document Published by the National Research Council of Canada (NRC)
1200 Montreal Road, Bldg. M58, Ottawa, ON, K1A 0R6, Canada
Telephone: (613) 993-2463 or 1-800-672-7990

- NBC 2010, National Building Code of Canada
-

Standard Published by ULC Standards
7 Underwriters Road, Toronto, ON M1R 3A9 Canada
Telephone: (416) 757-3611 or 1-866-9373-ULC, "ATTN: Publications"
E-mail: publications@ulc.ca
www.ulc.ca

- CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - CAN/ULC-S525-14, Audible Signalling Devices for Fire Alarm and Signalling Systems, Including Accessories
 - CAN/ULC-S526-14, Visible Signalling Devices for Fire Alarm Systems, Including Accessories
 - CAN/ULC-S527-11, Control Units and Accessories for Fire Alarm Systems
 - CAN/ULC-S541-14, Speakers for Fire Alarm and Signalling Systems, Including Accessories
 - CAN/ULC-S559-13, Equipment for Fire Signal Receiving Centres and Systems
 - CAN/ULC-S561-13, Installation and Services for Fire Signal Receiving Centres and Systems
 - ULC/ORD-C1703, Flat-Plate Photovoltaic Modules and Panels
-

Document Published by the United States Department of Defense
Available from Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094
Telephone: (215) 697-2179
<http://assist.daps.dla.mil/quicksearch/>

- MIL-STD-810F, Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Test
-

Documents Published by the International Organization for Standardization (ISO)
Available from Information Handling Services Canada, 1 Antares Drive, Suite 200, Ottawa, ON, Canada, K2E 8C4
Telephone: 1-800-267-8220
www.ihscanada.ca

- ISO 8201, Acoustic Audible Emergency Evacuation Signal

Documents Published by Underwriters Laboratories Inc.
Available from COMM 2000, 1414 Brook Drive, Downers Grove, IL, U.S.A 60515
Telephone: 1-888-853-3503
www.comm-2000.com

- UL 1642-12, Lithium Batteries
- UL 2017-08, Standard for General-Purpose Signalling Devices and Systems

3 GLOSSARY

3.1 Terms used in this Standard that are in *italic* print are defined as follows (may not be consistent with other fire alarm standards and codes):

3.2 ACKNOWLEDGE – Action taken to confirm that a message or signal has been received, such as pressing a button.

3.3 ADVERSE CONDITION – Any condition occurring in a circuit or communication *path* that interferes with the proper signaling or interpretation of status-change signals or both. Conditions include radio frequency interference.

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

3.5 ALERT SIGNAL* – An audible signal to advise designated persons of an emergency.

3.6 AMBER ALERT – A notification typically issued when a child is abducted and public assistance is sought.

3.7 ANCILLARY DEVICE – A device which is activated by the system, but is not part of the *mass notification system* requirements.

ANCILLARY FUNCTION – A function which is activated by the system, but is not part of the *mass notification system* requirements.

ANCILLARY SIGNAL – A signal which is activated by the system, but is not part of the *mass notification system* requirements.

3.8 ANECHOIC CHAMBER – A room characterized by an unusually low degree of reverberation, simulating a free-field condition which is free from both internal and external acoustical interference.

3.9 ANNUNCIATOR – A unit containing one or more visible indicator(s), alphanumeric *display(s)*, or other equivalent means in which each indication provides status information about a circuit, condition, or location.

3.10 AUTONOMOUS CONTROL UNIT (ACU) – The primary local control unit for an *in-building mass notification system*, which monitors and controls signalling devices and other outputs for a protected premise or *building*.

3.11 BUILDING – Any structure used or intended for supporting or sheltering any use or occupancy*.

3.12 CENTRAL CONTROL STATION (CCS) – A facility with *Emergency Communication System (ECS)/Mass Notification System (MNS)* communications and control used in conjunction with one or more *Autonomous Control Units*, local wide area, or *wide area mass notification system* applications.

3.13 CHANNEL – A *path* for voice, data, or signal transmission. This may utilize the modulation of light, radio frequency, current, or voltage within a frequency band or other technologies.

3.14 CONTIGUOUS PROPERTY – A single owner or single user on a continuous plot of ground, including any *buildings* thereon, that is not separated by a public thoroughfare, transportation right-of-way, property owned or used by others, or body of water not under the same ownership.

3.15 CONTROL LOCATIONS – Consists of an authorized personnel *operator interface* such as a *Local Operator Console (LOC) Autonomous Control Unit (ACU)*, or *Central Control Station (CCS)* that can obtain control of an audio network and the respective notification *zones*.

3.16 DAMP LOCATIONS – A location protected from sun, rain, and water, but may be subject to moisture. Such locations may include basements, barns, cold-storage warehouses, greenhouses, indoor swimming facilities, and the like. They may also include partially protected locations under canopies, marquees, roofed open porches, and the like.

3.17 DATA COMMUNICATION LINK FOR DEVICES – A data *channel* between any combination of addressable appliances or devices, circuit interfaces, control units, or transmitters over which multiple input signals output signals or both are carried.

3.18 DATA COMMUNICATION LINK FOR NETWORKS – Supervised data *channel* for providing a data connection and control circuits between a life safety system within a *building* and a *Central Control Station* and/or other control/annunciation systems on contiguous or *non-contiguous property*. Example – Ethernet data connection from a *building* on a campus and a management/safety facility that monitors and controls the *building* system.

3.19 DIRECTIVITY – The response (audibility) of a transducer as a function of the direction of the transmitted sound waves in a specified plane and at a specified frequency.

3.20 DISPLAY – The visual representation of output data or status information, other than printed copy.

3.21 DISTRIBUTED RECIPIENT MASS NOTIFICATION SYSTEM (DRMNS) – A system intended to communicate to targeted individuals that may not be in a contiguous area.

3.22 DISTRIBUTED RECIPIENT MASS NOTIFICATION SYSTEMS – HYBRID-PREMISE-BASED – A system hosted within a customer's internal network, connecting to hosted notification distribution capabilities, such as text messaging, voice telephony, email, etc. The on premise components of this system must comply with this standard.

3.23 DISTRIBUTED RECIPIENT MASS NOTIFICATION SYSTEMS - PREMISE-BASED – A system hosted within a customer's internal network intended to communicate to targeted individuals that may or may not be in a contiguous area.

3.24 DRY LOCATIONS – A location with a controlled ambient that is not subject to dampness or wetness.

3.25 EMERGENCY COMMUNICATION SYSTEM/MASS NOTIFICATION SYSTEM (ECS/MNS) – A configuration of components and interfaces that are used to communicate information to occupants in a *building*, area site, or other space about emergency conditions. Systems may consist of equipment that can reproduce live and recorded voice messages, tones and visual indicators such as strobe lights and visual *displays*.

3.26 EMERGENCY CONDITION – A sudden and/or unusual event that may impart harm to a being, operation, facility or similar entity that requires immediate action or response. Examples of an emergency event – terrorism, fire, security breach, inclement weather. Examples of a non-emergency event – sales updates, general paging, music.

3.27 EMERGENCY VOICE/ALARM COMMUNICATIONS – Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as *evacuation* signals pertaining to an emergency, to the occupants of a *building*.

3.28 END-OF-LINE DEVICE – A device installed at the end of a circuit for the purpose of monitoring the circuit for *fault* conditions.

3.29 EVACUATION – The withdrawal of occupants from a *building*.

3.30 EVACUATION SIGNAL – Distinctive signal intended to be recognized by the occupants as requiring *evacuation* of the *building*.

3.31 EXECUTIVE SOFTWARE – Control and supervisory program which manages the execution of all other programs and directly or indirectly causes the required functions of the product to be performed.

3.32 EXTERNAL CIRCUITS – Circuits or wiring leaving the product.

3.33 EXTRA LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 30 V alternating current (AC) rms, 42.4 V direct current (DC) or peak.

3.34 FAILOVER – Automatically switching to a different, redundant system upon failure or abnormal termination of the currently active system.

3.35 FAULT – An open, open circuit, ground, or short-circuit condition on any line extending from a product.

3.36 FIELD WIRING – Conductors connecting the product to source(s) of supply, devices, other products, and loads.

3.37 FIXED EQUIPMENT – Any equipment product that is intended to be permanently connected electrically to the wiring system.

3.38 GATEWAY – A device that is used in the transmission of digital or analog data from the emergency system to non-emergency *building*-systems control units, equipment, or networks, and/or from non-emergency *building* system control units to the emergency system.

3.39 GROUND FAULT – An impedance to ground such that the occurrence of a subsequent impedance to ground on any extended conductor in the system would derange the system.

3.40 GROUNDED CONDUCTOR – A conductor employed to connect the intentionally grounded circuit of a wiring system to a grounding electrode.

3.41 GROUNDING CONDUCTOR – A conductor employed to connect non-current-carrying parts of equipment, raceways, and enclosure to a grounding electrode at the service which is, in turn, connected to earth ground or to some conducting body which serves in place of earth ground.

3.42 HIGH POWER SPEAKER ARRAY (HPSA) – A product providing capability for voice and tone communication to large outdoor areas.

3.43 IN-BUILDING MASS NOTIFICATION SYSTEM – A system used to provide information and instructions to occupants in a *building* or other space using voice communication, visible signalling and other communication methods.

3.44 INITIATING/INPUT DEVICE – A manually or automatically operated device, the normal intended operation of which results in signal indication from the product/system.

3.45 INPUT CIRCUIT – Circuit to which automatic or manual *input devices* are connected where the signal received does not identify the individual device operated.

3.46 INPUT ZONE – A defined area within the *protected premises* that contains one or more *Initiating/ Input Devices*, for which a status indication can be received.

3.47 LIFE SAFETY NETWORK – A type of combination system that transmits life safety data through *gateways* to other life safety systems.

3.48 LOCAL OPERATING CONSOLE (LOC) – An *in-building mass notification system* operating console for authorized occupants to initiate messages and signaling in an *emergency condition*.

3.49 LONG-RANGE RADIO-FREQUENCY DEVICES – Any device that communicates between a *protected premises* and a subsidiary station, *supervising station*, or another *protected premises* using a private radio network.

3.50 LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 300 V nominal and having characteristics in excess of those of a low-voltage circuit.

3.51 MASS NOTIFICATION SYSTEM/EMERGENCY COMMUNICATION SYSTEM (MNS/ECS) – A configuration of components and interfaces that are used to communicate information to occupants in a *building*, area site, or other space about *emergency conditions*. Systems may consist of equipment that can reproduce live and recorded voice messages, tones and visual indicators such as strobe lights and visual *displays*.

3.52 NON-CONTIGUOUS PROPERTY – A series of plots of land under the same ownership including any *buildings* thereon that are separated by a public thoroughfare, transportation right-of-way, property used by others, or body of water, not under the same ownership.

3.53 NON-EMERGENCY FUNCTION – A function not associated with property protection and/or life safety.

3.54 NON-VOLATILE MEMORY – A storage device not alterable by the interruption of the power to the memory; for example, ROM, FLASH, PROM, EPROM, and EEPROM.

3.55 OPEN CIRCUIT FAULT – A circuit impedance increase sufficient to prevent normal operation.

3.56 OPERATOR INTERFACE – Also referred to as a User Interface. The man-machine *display* and/or control point of a system that provides information as to system status and may provide system input or action capabilities so that the human operator may invoke commands and/or requests for

information to the system. Systems may have one or more Operator Interfaces. This interface may be, but are not limited to a Graphical User Interface (GUI) such as a computer screen, a Liquid Crystal Display (LCD), Light Emitting Diodes (LED) or other luminary indicators and/or audible indicators and/or tactile *displays*.

3.57 OUTPUT CIRCUIT – A circuit connected directly to field devices and employed to provide an *alert signal*, *alarm signal* or other output functions.

3.58 PATH – Any conductor, optic fiber, radio carrier, or other means for transmitting information between two or more units and/or locations.

3.59 POWER-LIMITED/CLASS 2/3 CIRCUIT A circuit wherein the power is limited as specified in Table 21.

3.60 POWER SUPPLY – A source of electrical operating power including the circuits and terminations connecting it to the dependent product/system components.

3.61 PRE-ANNOUNCE TONE – An attention-getting signal to alert occupants of the pending transmission of a voice message.

3.62 PRE-RECORDED MESSAGE DEVICE – An automatically- or manually-actuated device intended to translate a pre-recorded message stored on a tape or other medium into an electronic signal that when amplified and introduced into speakers produces vocal or tonal information.

3.63 PRIMARY BATTERY – Any battery which is the primary power source for the unit.

3.64 PROTECTED PREMISES – The physical location serviced by a *mass notification system*.

3.65 RESET – A control function that attempts to return a system or device to its normal non-emergency state.

3.66 REPEATER – Equipment used to relay signals between a remote unit, *initiating device* or similar device and the receiving unit.

3.67 RISK OF ELECTRIC SHOCK – A risk of electric shock is determined to exist within a circuit unless that circuit meets one of the following criteria:

- A The circuit is supplied by an isolating source such that the maximum open-circuit voltage potential available to the circuit is not more than 30 V AC rms, 42.4 V DC, or 42.4 V peak; or
- B The circuit is supplied by an isolating source such that the current available through a 1500 Ω resistor connected across any potential in the circuit (including to ground) does not exceed 5 mA.

3.68 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

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

3.69 SECONDARY POWER SOURCE – Provides power when the primary power source fails.

3.70 **SHARED SYSTEM** – An emergency alarm system whose components might be used, in whole or in part, in common with a non-emergency *alarm signaling* system such as smoke control, security, non-critical process monitoring, paging, or *building* automation.

3.71 **SHORT MESSAGE SERVICE (SMS)** – A communication service using standardized communications protocols allowing the interchange of short text messages to and between mobile telephone devices. A SMS message can handle up to 160 characters including spaces.

3.72 **SHORT-RANGE RADIO FREQUENCY DEVICE** – Any device that communicates with control/receiving equipment at the *protected premises* by low-power radio signals in accordance with the applicable Industry Canada Radio Standards Specifications.

3.73 **SIGNALLING DEVICE** – A component that provides audible, tactile, or visible outputs or any combination thereof.

3.74 **SIGNAL RECEIVING CENTRE** – A facility that receives *alarm signals* and at which trained personnel and service persons are on duty at all times.

3.75 **SIGNALLING CIRCUIT** – A circuit or *path* directly connected to a *signalling devices(s)*. Examples include circuits that connect to non-addressable speakers, strobe lights, horns, chimes and other indicating appliances.

3.76 **SIGNALLING ZONE** – An area covered by *signalling devices* that are activated simultaneously.

3.77 **SITE-SPECIFIC PROGRAMMING** – Program that is separate from, but controlled by the *executive software* which allows inputs, outputs, and system configuration to be selectively defined to meet the needs of a specific installation.

3.78 **SOFTWARE** – Programs, instructions, procedures, data, firmware, and the like that are executed by a central processing unit of a product and which influences the functional performance of that product. Composed of *executive software* and *site-specific programming*.

3.79 **STATIONARY EQUIPMENT** – Any product that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

3.80 **STIPA TEST SIGNAL** – A special audio signal that consists of signals in seven octave bands and which each octave band is modulated using two separate modulation frequencies that is played over the emergency communications system being tested. STIPA is standardized in IEC 60268-1, Sound System Equipment Part 1: General.

3.81 **STORAGE BATTERY** – Any battery which, by design or construction, is intended to be recharged.

3.82 **SUPERVISING STATION** – The *operator interface* system to which alarm and *trouble signals* are directly monitored or are received from remote monitoring units. Intended to be constantly attended and maintained by competent and experienced personnel. This may be a *signal receiving centre*.

3.83 **SUPERVISORY SIGNAL** – A visual and audible signal indicating the need for action in connection with opening of enclosure doors, tamper signals, or maintenance features of related systems.

3.84 **SUPPLEMENTARY** – Refers to equipment or operations not required by this standard.

3.85 SUPPLEMENTARY CIRCUIT OR PATHWAY – A circuit or pathway provided by a product for controlling a device, the operation of which is *supplementary* to the requirements of this standard.

3.86 SUPPLEMENTARY DEVICE – A device that has not been investigated to this standard intended to be connected to a supplementary device circuit.

3.87 TONE GENERATOR – A device intended to generate an electronic signal that, when amplified and introduced into speakers, produces a non-prerecorded, non-vocal, audible signal.

3.88 TROUBLE SIGNAL – A visual or audible signal indicating a *fault* condition of any nature, such as a circuit break or ground or other trouble condition occurring in the device or wiring associated with a protective signaling system.

3.89 TWO FACTOR AUTHENTICATION – The presentation of two or more of the three authentication factors: a knowledge factor ("something the user knows"), a possession factor ("something the user has"), and an inherence factor ("something the user is").

3.90 USER – An individual who operates or services the product.

3.91 WET LOCATIONS – A location subject to rain (or the spray of noncorrosive and nonflammable liquids) that may become saturated with water or that is unprotected from the weather. Includes locations underground, or in concrete slabs or masonry in direct contact with the earth.

3.92 WIDE AREA MASS NOTIFICATION SYSTEM – A system which provides real time information to areas, including outdoor, in a contiguous or non-contiguous campus, region or global geographical setting.

3.93 WIRE-TO-WIRE FAULT – A wire-to-wire (short circuit) *fault* is determined to be a resistance of 0.1 ohm or less across the circuit.

3.94 ZONE – A defined area within the *protected premises*. A zone defines an area from which a status indication can be received or an area in which a form of control can be executed.

*Definition of this term is consistent with that used in the National Building Code of Canada

CONSTRUCTION

4 GENERAL

4.1 A product shall use materials that have been determined to comply with the requirements for the particular use, as indicated by the performance requirements of this standard.

4.2 Metals, when required to meet the requirements of this standard, shall not be used in such combination as to cause galvanic action that will increase the *risk of fire*, electric shock, injury to persons, or impair the operation of a product associated with the safety of life and/or property protection.

4.3 Where breakage or deterioration of a part such as an enclosure, a frame, a guard, or the like can result in a risk of injury to persons, the part shall be constructed to meet the demand or expected loading conditions.

4.4 The requirement in Clause 4.3 applies also to those positions of a part adjacent to a moving part identified to involve a risk of injury to persons.

4.5 Products that currently meet the requirements of CAN/CSA C22.2 No. 60950-1, Information Technology Equipment Safety — Part 1: General Requirements, need only be evaluated to the following sections with respect to the construction requirements: 5.1, 8.5, 10.1, 10.2, 11.1 – 11.3, 11.6, 13.4, 18, 22.1, 24.3, and 26.

5 ENCLOSURES

5.1 GENERAL

5.1.1 All electrical parts of a product shall be enclosed to provide protection of internal components and prevent contact with uninsulated live parts.

5.2 METALLIC MATERIAL

5.2.1 An enclosure of metal shall have a minimum thickness as specified in Tables 1, 2, or 3, or shall comply with the test requirements in Mechanical Strength Tests for Metal Enclosures and Guards, Section 65.

5.2.2 Where threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or where a construction that is determined to be equivalent is used, there shall not be less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing can be attached.

5.2.3 Where 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 five 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.

5.2.4 At any point where conduit or metal-clad cable is to be attached to the enclosure, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have stiffness at least equivalent to that of an uncoated flat sheet of steel having a minimum thickness of 0.81 mm (0.032 in).

5.3 POLYMERIC MATERIALS

5.3.1 Polymeric materials used as an enclosure shall comply with the applicable portion of CAN/CSA-C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials, and also with the additional requirements specified in this standard.

5.3.2 Polymeric material that is not used as an enclosure, but that is attached to or exposed on the outside of a product such as a viewing window, shall have flammability characteristics as shown in Table 4.

5.3.3 Conductive coatings applied to nonmetallic surfaces such as the inside surface of an enclosure, shall comply with the appropriate requirements in CAN/CSA-C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials unless flaking or peeling of the coating cannot result in the reduction of spacings or the bridging of live parts.

5.3.4 A polymeric enclosure intended for connection to a rigid metallic conduit system shall comply with the requirements for polymeric enclosure rigid metallic conduit connections in the CAN/CSA C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-Environmental Considerations, and CAN/CSA C22.2 No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations.

5.3.5 The continuity of a conduit system shall be provided by metal-to-metal contact and not rely on a polymeric material and shall comply with the requirements for polymeric enclosure bonding in the CAN/CSA C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-Environmental Considerations, and CAN/CSA C22.2 No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations.

5.4 COVERS

5.4.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached to provide access to fuses or any other over current-protective device, the intended protective functioning of which requires renewal or resetting, or when it is necessary to open the cover in connection with the normal operation of the unit.

Exception: In lieu of providing a hinged, sliding, or pivoted cover, supervision of the enclosure cover by means of a tamper feature is suitable when its operation results in either a trouble or alarm signal. This applies only when the cover provides access to overcurrent devices such as fuses or circuit breakers or other indicators that are not used on a continuing basis.

5.4.2 Normal operation referenced in Clause 5.4.1 is determined to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit which requires such action in connection with its intended performance.

5.4.3 A hinged cover is not required when the only fuse(s) enclosed is intended to provide protection to portions of internal circuits used on a separate printed-wiring board or circuit subassembly, to prevent circuit damage resulting from a *fault*. The use of such a fuse(s) is suitable when the following (or other wording that has been determined to be equivalent) is indicated as a marking on the outside of the cover: "Circuit Fuse(s) Inside - Disconnect Power Prior To Servicing."

5.4.4 Glass covering an observation opening shall be tempered and secured in place so that it cannot be displaced and shall provide mechanical protection for the enclosed parts. The thickness of a glass cover shall not be less than that indicated in Table 5.

5.4.5 A glass panel for an opening having an area of more than 929 cm² (144 in²), or having any dimension greater than 305 mm (12 in), shall be supported by a continuous groove not less than 4.8 mm (3/16 in) deep along all four edges of the panel, or other means that have been determined to be an equivalent arrangement.

5.4.6 A transparent material other than glass used for the cover of an observation opening shall not introduce a *risk of fire*, distort, nor become less transparent at the temperature to which it is intended to be subjected under either normal or abnormal service conditions. See Clause 5.3.2.

5.5 BATTERY COMPARTMENTS

5.5.1 A compartment for vented storage batteries shall have a total volume at least twice the volume occupied by the batteries. Ventilating openings shall be provided and so located as to permit circulation of air for dispersion of gas while the battery is being charged at the highest rate permitted by the means incorporated in the control unit.

5.5.2 The interior of a *storage battery* compartment shall be protected so that it will be resistant to detrimental action by the electrolyte.

5.6 ENCLOSURE OPENINGS — GENERAL

5.6.1 An enclosure intended for recessed mounting and whose front panel is 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.

Exception: Products supplied solely from sources less than 30 V, root-mean-square (rms) or 42.4 V peak, and less than 100 VA.

5.6.2 The requirement in Clause 5.6.1 does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

- A An opening for non-mounting purposes does not have a dimension greater than 6.75 mm (17/64 in) or an area greater than 35.5 mm² (0.055 in²); and
- B An opening for mounting does not have a dimension greater than 19.05 mm (0.75 in) or an area greater than 430 mm² (0.7 in²) and there are no more holes than are needed to mount the product.

5.7 ENCLOSURE TOP OPENINGS

5.7.1 An opening directly over an uninsulated live part involving a *risk of fire*, electric shock, or electrical-energy/high-current levels, shall not exceed 5.0 mm (0.20 in) in any dimension unless the configuration is such that a vertically falling object cannot fall into the unit and contact an uninsulated live part. See Figure 1 for examples of top-cover designs complying with the intent of the requirement.

5.8 ENCLOSURE SIDE OPENINGS

5.8.1 An opening in the side of the enclosure shall:

- A Not exceed 4.8 mm (0.19 in) in any dimension;
- B Be provided with louvers shaped to deflect an external falling object outward (see Figure 2 for examples of louver designs complying with the requirement); or
- C Be located and sized so that objects which are present cannot drop into the unit and fall (with no horizontal velocity) onto uninsulated live parts involving a *risk of fire*, electric shock, or electrical-energy/high-current levels, or parts involving injury to persons (see Figure 3).

5.8.2 When a portion of a side panel falls within the area traced out by the 5° angle in Figure 4, that portion of the side panel shall be investigated as a bottom enclosure in accordance with Clauses 5.9.1 – 5.9.3.

5.9 ENCLOSURE BOTTOM OPENINGS

5.9.1 The bottom of an enclosure shall consist of a complete or partial bottom enclosure under a component, groups of components, or assemblies, as shown in Figure 4, that complies with the ventilation opening requirements in Clauses 5.9.2 and 5.9.3 unless a test demonstrates that the bottom enclosure provided contains flames, glowing particles or similar burning debris when all combustible material in the interior is ignited.

Exception: Openings without limitation on their size and number are permitted in areas that contain only wires, cables, plugs, receptacles, and impedance- and thermally-protected motors.

5.9.2 Ventilation openings provided in the bottom of an enclosure under materials that are not rated V-1 or less flammable meet the intent of the requirements when the openings are constructed so that materials do not fall directly from the interior of the unit. Other bottom-opening constructions that comply with the intent of the requirements are those that incorporate a perforated metal plate as described in Table 6, or a galvanized or stainless-steel screen having a 25.4 mm (14 by 14 mesh per 1 in) constructed of wire with a minimum diameter of 0.4 mm (1/64 in). Other constructions are to be used only when they comply with the Ignition Test Through Bottom-Panel Openings, Section 61.

5.9.3 The bottom of the enclosure under areas containing only materials rated V-1 or less flammable shall have openings no larger than 40 mm² (1/16 in²).

6 INTERNAL MATERIALS

6.1 Polymeric materials used within an enclosure shall be evaluated in accordance with the CAN/CSA-C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials.

Exception: Unrated resistors, capacitors, semiconductors, integrated circuit packages, optical isolators, and similar electrical components meet the intent of the requirement when they are mounted on a material with a minimum flammability rating of V-1.

6.2 All combustible material used within an enclosure shall be V-2, HF-2, or better.

Exception: Motors, relays, capacitors, semiconductors, transformers, switches, insulating tubing or tape, and other electrical elements are exempt from the above requirement when they comply with the flame test applicable to the component. Meter faces and cases (when determined capable for mounting live parts) and indicator lamps or jewels, or both, are exempt from flammability requirements. The following requirements apply to parts that are isolated either by at least 12.5 mm (0.5 in) of air, or a solid barrier of V-1 or less-flammable material from uninsulated electrical parts that involve a risk from electrical energy-high current levels:

- A Gears, cams, belts, bearings, strain-relief bushings applied over PVC-jacketed cords, and other small parts that contribute negligible fuel to a fire are not required to be investigated; and*
- B Tubing for air or fluid systems, and foamed plastics, shall not be more flammable than HB. Foamed plastics classed HBF in accordance with the CAN/CSA-C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials, are determined as complying with this requirement.*

7 ACCESSIBILITY OF UNINSULATED LIVE PARTS, FILM-COATED WIRES, AND MOVING PARTS

7.1 To reduce the risk of unintentional contact and electric shock from an uninsulated live part or film-coated wire, and injury to persons from a moving part, an opening in an enclosure shall have a minor dimension less than 25.4 mm (1 in), and such a part or wire shall not be contacted by the probe illustrated in Figure 5.

7.2 The probe illustrated in Figure 5 shall be applied to any depth that the opening will permit. The probe shall be rotated or angled before, during, and after insertion through the opening to any position that is required in order to examine the enclosure. The probe illustrated in Figure 5 shall be applied in any possible configuration and, when necessary, the configuration shall be changed after insertion through the opening.

7.3 The probe illustrated in Figure 5 shall be used as a measuring instrument to evaluate the accessibility provided by an opening, and not as an instrument to evaluate the strength of a material. It shall be applied with the minimum force required to determine accessibility.

7.4 During the examination of a product to determine whether it complies with the requirement in Clause 7.1, a part of the enclosure that is to be opened or removed by the operator without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) shall be opened or removed.

8 MECHANICAL ASSEMBLY

8.1 All parts of a product shall be mounted in position and prevented from loosening or turning when such motion may adversely affect the performance of the product, or may increase the *risk of fire*, electric shock, and/or injury to persons incident to the operation of the product.

8.2 A switch, fuse holder, lampholder, attachment-plug receptacle, motor-attachment plug, or other similar component shall be mounted securely and shall not turn.

Exception No. 1: When the turning of a switch is possible, all four of the following conditions shall be met:

- A The switch shall be of a plunger, slide, 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 intended operation of the switch;*
- B The means for mounting the switch makes it unlikely that operation of the switch loosens it;*
- C The spacings are not reduced below the minimum required values when the switch rotates; and*
- D The intended operation of the switch is by mechanical means rather than by direct contact by persons.*

Exception No. 2: When rotation does not reduce spacings below the minimum required value, a lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, complies with the intent of the requirement.

8.3 Friction between surfaces shall not be used for securing the position of the parts specified in Clause 8.2.

8.4 A rotating part that by loosening presents a *risk of fire*, electric shock, electrical-energy/high-current levels, or injury to persons, shall be assembled so that the direction of rotation tends to tighten the means that hold the rotating part in place.

Exception: A keyed part, a press fit, a part locked in place with a pin, or means that have been determined to be equivalent, can be used to hold a rotating part in place.

8.5 All subassemblies, modules, and printed-wiring boards shall be held in their intended place in the product by mechanical means.

9 PROTECTION AGAINST CORROSION

9.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other means that have been determined to be equivalent, when corrosion of unprotected parts results in a *risk of fire*, electric shock, injury to persons, or impairment of operation of a product.

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure are not required to be protected against corrosion when oxidation of the metal due to exposure to air and moisture is not likely to weaken the parts to result in a condition of risk. The thickness of metal and temperature are also to be evaluated.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and similar equipment, are not required to be protected against corrosion.

10 BRANCH-CIRCUIT CONNECTION

10.1 GENERAL

10.1.1 Control units and accessories shall be provided with a means for permanent connection to the branch-circuit supply in accordance with CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

Exception: Video display terminals, other operator interface products, and printers installed within a supervising station that may be repositioned for normal use or maintenance.

10.1.2 When a control unit and its accessories require two or more supply circuits, the installation wiring drawing required by Section 80, Installation & Drawings, shall detail grouping, identification and warning markings of the disconnecting means as required by CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

10.2 PERMANENTLY CONNECTED

10.2.1 General

10.2.1.1 A product intended for permanent connection to the branch-circuit supply shall have provision for installing the supply conductors in rigid metallic conduit.

Exception: An enclosure without provisions for connection to rigid metallic conduit is acceptable when the installation instructions specifically indicate which sections of the enclosure may be drilled for the connection.

10.2.1.2 A knockout or other supply-connection opening located where temperatures in excess of 60°C (140°F) have been measured during the Component Temperature Test, Section 52, and not having qualifying marking as specified in Clause 79.1.13, shall be sealed by welding or the equivalent or be permanently marked adjacent to the opening with: "Do Not Use".

10.2.2 Field-Wiring Compartment

10.2.2.1 The location of a terminal box or compartment, in which branch-circuit connections to a permanently-wired product are to be made, shall be such that the connections can be readily inspected without disturbing the wiring or the product after the product has been installed as intended.

10.2.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the product so that it does not turn.

10.2.2.3 The field-wiring compartment area of a product shall be of sufficient size for completing all wiring connections as specified by the installation wiring diagram.

10.2.2.4 Where damage to field-wiring insulation may be caused by internal components or sharp edges in the wiring compartment, insulating or metal barriers having smooth, rounded edges shall be provided or the following or equivalent wording marked in the wiring area: "CAUTION – When Making Installation, Route Field Wiring Away From Sharp Projections, Corners, and Internal Components" «MISE EN GARDE – Lors de l'installation, Route du câblage loin de protubérances, Corners, et les composants internes.»

10.2.2.5 The wiring terminals of a product intended for mounting in an outlet box shall be located or protected so that, upon installation, the wiring in the outlet box is not forced against the terminals or other sharp edges so as to damage the conductor insulation, and/or the terminals or stripped leads do not come into contact with the walls of the outlet box.

10.2.3 Field-Wiring Terminals and Leads

10.2.3.1 A permanently connected product shall be provided with wiring terminals or leads for the connection of conductors having an ampacity not less than 125 % of the current input of the product when connected to a power-supply voltage in accordance with Clauses 29.1.1 – 29.1.4.

10.2.3.2 The free length of a lead inside a terminal box or compartment shall be 150 mm (6 in) or more, provided with strain relief, shall not be smaller than 0.82 mm² (18 AWG), and the insulation, when of rubber or thermoplastic, shall not be less than 0.8 mm (1/32 in) when the lead is intended for field connection to an external circuit.

Exception: The lead shall be less than 150 mm (6 in) long when it is evident that the use of a longer lead results in a risk of fire or electric shock

10.2.3.3 A field-wiring terminal shall be kept from turning or shifting in position by means other than friction between surfaces. 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 some other method determined to be the equivalent.

10.2.3.4 A field-wiring terminal shall comply with the requirements in Clause 11.4 for field-wiring terminals (general application) except a wire-binding screw shall not have a diameter smaller than 4.2 mm (No. 8).

10.2.4 Identified Terminals and Leads

10.2.4.1 A permanently-connected product rated 3-wire (125 or 125/250 V) or less, and using a lampholder of the Edison screw-shell type, or a single-pole switch or overcurrent protective device other than an automatic control without a marked-off position, shall have one terminal or lead identified for the connection of the *grounded conductor* of the supply circuit. This terminal or lead shall be electrically connected to screw shells of lampholders and shall not be connected to switches or overcurrent protective devices of the single-pole type other than automatic controls without a marked-off position.

10.2.4.2 A terminal intended for the connection of a grounded supply conductor shall be of or plated with metal that is white in color and shall be distinguishable from the other terminals, or identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram.

10.2.4.3 A lead intended for the connection of a grounded power-supply conductor shall be finished white or gray color and shall be distinguishable from the other leads.

10.2.5 Strain Relief

10.2.5.1 A means of strain relief shall be provided for the field supply leads of a product to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of the leads provided with a ring-type strain relief or means determined to be the equivalent shall not damage internal connections or components, or result in a reduction of electrical spacings.

10.2.5.2 Each lead used for field connections or an internal lead subjected to movement or handling during installation and servicing shall be capable of withstanding for 1 min a pull of 4.54 kg (10 lb) without any evidence of damage or of transmitting the stress to internal connections.

10.3 CORD-CONNECTED PRODUCT

10.3.1 Cords and Plugs

10.3.1.1 A product shall be provided with a length of 1.5 – 4.5 m (5 – 15 ft) flexible cord and a grounded attachment plug when intended for connection to a line voltage branch-circuit supply. See Tables 7 and 8.

Exception No. 1: A length of flexible cord of Type S, or cord determined to be equivalent, not exceeding 7.5 m (25 ft).

Exception No. 2: The length of the power-supply cord on an appliance intended for a special installation, such as dedicated equipment intended to be mounted near a receptacle may be less.

Exception No. 3: A polarized attachment plug, rather than a grounded attachment plug, when the product has no accessible dead-metal parts likely to be energized.

Exception No. 4: An attachment plug is not required to be polarized or grounded when there are no accessible dead-metal parts likely to be energized and no single-pole devices in primary circuits.

Exception No. 5: Double insulated equipment shall not be grounded. Refer to the CAN/CSA-C22.2 No. 182.4-1990, Plugs, Receptacles and Connectors for Communication Systems, and CAN/CSA-C22.2 No. 233-1989, Cords and Cord Sets for Communication Systems.

10.3.1.2 The flexible cord shall have a voltage rating not less than the rated voltage of the product, and shall have an ampacity that is not less than the current rating of the product.

10.3.1.3 The flexible cord on a cord-connected unit shall be as indicated in Table 8 or shall be of a type at least as serviceable for the particular application. Table 9 specifies cord types determined to be equivalent to those specified in Table 9.

10.3.1.4 The current rating of the attachment plug shall not be less than 125 % of the product nameplate rating.

10.3.1.5 The voltage rating of the attachment plug shall correspond to the rated voltage of the product. When a product is intended for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided with the product shall be rated for the voltage for which the product is wired when shipped from the factory.

10.3.1.6 The flexible cord shall be attached permanently to the product and means shall be provided to physically secure the attachment plug or plug-in transformer to the power receptacle so as to prevent accidental removal.

Exception: For monitors and other operator interface products, a detachable power-supply cord without physical securing means is suitable.

10.3.2 Strain Relief

10.3.2.1 A power-supply cord shall be provided with strain-relief means to keep tension on the cord from being transmitted to terminals, splices, or wiring within the product. The strain-relief means provided shall comply with the Strain-Relief Test, Section 70.

10.3.2.2 Means shall be provided so that the flexible cord cannot be pushed into the product through the cord entry hole when such displacement results in damage to the cord or exposure of the cord to a temperature higher than that for which the cord is rated or can reduce spacings, such as to a metal strain-relief attachment, below the minimum required values.

10.3.2.3 A metal strain-relief clamp or band (without auxiliary protection) has been determined to be suitable with Type SJ, S, SJT, ST or similar jacketed cords. A metal strain-relief clamp or band has been determined to be suitable with Type SV, SP-2, SPT-2, or SVT cords only when nonconducting auxiliary mechanical protection is provided over the cord.

10.3.2.4 A knot shall not be used to provide strain relief.

10.3.2.5 When tested in accordance with Clauses 70.1.1 – 70.1.3, the strain-relief means provided on the flexible cord shall be capable of withstanding for one min, a pull of 15.9 kg (35 lb) applied to the cord, with no evidence of stress on the interior connections.

10.3.3 Bushings

10.3.3.1 At the point at which a supply cord passes through an opening in a wall, barrier, or the overall enclosure, there shall be a bushing or a determined equivalent that shall be secured in place, and shall have a smooth, well-rounded surface against which the cord tends to bear. When other than a jacketed cord is used and the wall or barrier is of metal, an insulation bushing shall be provided.

10.3.3.2 When the cord hole is in porcelain, phenolic composition, or another rated nonconducting material, a smooth, well-rounded surface is determined equivalent to a bushing.

10.3.3.3 Ceramic materials and some molded compositions are capable of being used for insulating bushings.

10.3.3.4 Vulcanized fiber is not prohibited from being used when the bushing is not less than 1.2 mm (3/64 in) thick and is formed and secured in place so that it will not be affected adversely by conditions of ordinary moisture.

10.3.3.5 A separate soft-rubber, neoprene, or polyvinyl chloride bushing shall only be used on a supply cord where the cord enters the frame of a motor or the enclosure of a capacitor that is physically attached to a motor when the bushing is:

- A Not less than 1.2 mm (3/64 in) thick; and
- B Located so that it will not be exposed to oil, grease, oil vapor, or other substances that tend to have a deleterious effect on the compound used.

10.3.3.6 A bushing of any of the materials specified in Clause 10.3.3.5 on a supply cord anywhere in a product is acceptable when it is used in conjunction with a type of cord for which an insulating bushing is not required. The edges of the hole in which such a bushing is used are required to be free from burrs, fins, and other conditions that could damage the bushing.

10.3.3.7 At any point in a product, a bushing of the same material as, and molded integrally with, the supply cord is capable of being used on a Type SP-2 or heavier cord, when the thinnest section is not less than 1.6 mm (1/16 in) thick at the point where the cord passes through the enclosure.

10.3.3.8 An insulated metal grommet to be used in place of an insulating bushing meets the intent of the requirement, when the insulating material used is not thinner than 0.8 mm (1/32 in) and completely fills the space between the grommet and the metal in which the grommet is mounted.

11 OTHER FIELD-WIRING CONNECTIONS

11.1 GENERAL

11.1.1 A product shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, corresponding to the rating of the circuit.

11.1.2 All field-wiring connections shall be contained in either an enclosed *field wiring* compartment integral with the product or in a separate outlet box to which the product is to be mounted.

11.1.3 Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits of products intended to be connected to *input circuits*, *output circuits*, or non-addressable *data communication links of a control unit*; one for each incoming and one for each outgoing wire. It is not prohibited that a common terminal 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 supervision 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 not used and there is no provision to prevent looping an unbroken wire around or under one terminal, the information in Clause 80.10 shall be included in the installation wiring diagram/instructions.

11.2 FIELD-WIRING COMPARTMENT

11.2.1 There shall be adequate space within a terminal or wiring compartment to permit the use of a standard conduit bushing when a bushing is required for installation.

11.2.2 The field-wiring compartment area of a product to which connections are to be made is to be of sufficient size for completing all wiring connections as specified by the installation wiring diagram.

11.2.3 Where it is possible for damage to field-wiring insulation to be caused by internal components or sharp edges in the wiring compartment, insulating or metal barriers having smooth, rounded edges shall be provided or the following (or wording determined to be the equivalent) marked in the wiring area:

“CAUTION – When Making Installation, Route Field Wiring Away From Sharp Projections, Corners And Internal Components” «MISE EN GARDE – Lors de l'installation, Route du câblage loin de protubérances, les coins et les composants internes.»

11.2.4 The wiring terminals of a product intended for mounting in an outlet or junction type box shall be located or protected so that, upon installation:

- A The wiring in the outlet box is not forced against the product, product's terminals, or sharp edges so as to damage the conductor insulation or product's unprotected components; and/or
- B A product with exposed wiring terminals shall be held in its intended mounting location inside the box by mechanical means.

11.3 CLASS 1 OR 2 CIRCUITS

11.3.1 When the design of the product is such that the product either requires or permits Class 1 or *Class 2 circuit* conductors to occupy the same enclosure as other voltages from various systems, the enclosure shall comply to CAN/CSA C22.2 No.0-M91, General Requirements - Canadian Electrical Code Part 2.

11.3.2 The enclosure shall provide one or more cable openings into the enclosure. When a single opening is provided, a continuous and firmly fixed nonconductor, such as flexible tubing, shall be provided. This is required so that extra low voltage and low voltage conductors are segregated from each other. The installation document of the product shall completely detail cable entry routing of all conductors into the product.

11.3.3 The product shall be constructed so that, with all field-installed wiring connected to the product, a minimum 6.4 mm (1/4 in) separation is provided between all extra low voltage and low voltage conductors.

11.3.4 Compliance with Clause 11.3.3 shall be achieved:

- A By specific wire routing configurations that are detailed in the installation document; or
- B When a wire routing scheme will not maintain the required separation, barriers or nonconductive sleeving shall be used to provide separation.

11.4 FIELD-WIRING TERMINALS (GENERAL APPLICATION)

11.4.1 A field-wiring terminal to which field-wiring connections are made shall comply with the requirements in:

- A Clauses 11.4.2 – 11.4.5;
- B The field-wiring requirements in the CAN/CSA-C22.2 No. 223, Power Supplies with Extra-Low-Voltage *Class 2* Outputs;
- C The CAN/CSA-C22.2 No. 65, Wire Connectors, and CSA-C22.2 No. 88, Splicing Wire and Cable Connectors; or
- D The CSA-C22.2 No. 158, Terminal Blocks;

rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.

11.4.2 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 5.3 mm² (10 AWG) 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 in) thick. Securing screws of plated steel have been determined to meet the requirements.

11.4.3 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 a 2.1 mm² (14 AWG) and a 2.8 mm (No. 4) diameter screw is appropriate for use for the connection of a 0.65 mm² (19 AWG) or smaller conductor.

11.4.4 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; and
- B Be of a nonferrous metal not less than 1.3 mm (0.050 in) thick when used with a 4.2 mm (No. 8) diameter or larger screw, and not less than 0.76 mm (0.030 in) thick when used with a 3.5 mm (No. 6) diameter or smaller screw.

11.4.5 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.

11.5 FIELD-WIRING TERMINALS (QUALIFIED APPLICATION)

11.5.1 Any of the following terminal configurations are suitable for connection of *field wiring* when all of the conditions in Clause 11.5.2 are met:

- A Telephone-Type Terminals – Nonferrous terminal plates using a narrow, V-shaped slot for securing of a conductor in a special post design (requires a special tool for wire connection);
- B Solderless Wrapped Terminals – Solderless, wrapped, nonferrous terminals which require a special tool and terminal post design;
- C 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;
- D Push-In Terminals – Nonferrous (screwless), push-in terminals 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; or
- E Other Terminals – Other terminal connections are not prohibited when determined to be equivalent to (a) – (d) and are limited to the same restrictions.

11.5.2 Any of the terminal configurations listed in Clause 11.5.1 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 0.13 mm² (26 AWG);
- C The wire size to be used shall be rated for the current-carrying capacity of the circuit application;
- D Removal of a lead for testing or routine servicing, including detection, location, and correction of installation wiring *faults*, is prohibited;
- E A means for testing for an open and a *ground fault* on the circuit(s) to which the wiring is connected shall be incorporated into the control unit or indicated on the installation wiring diagram; and
- F The terminal assembly shall comply with the Tests on Special Terminal Assemblies, Section 64.

11.6 FIELD-WIRING LEADS

11.6.1 General

11.6.1.1 Leads provided for splice connections shall be minimum 153 mm (6 in) long.

Exception: The free-lead length is not prohibited from being less than 153 mm long when it is evident that the use of a longer lead results in damage to the lead insulation or product, or in a risk of fire, electric shock, or injury to persons.

11.6.1.2 A means of strain relief shall be provided for the *field wiring* leads, and all internally connected wires which are subject to movement in conjunction with the installation, operation, or servicing of a product to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of the leads provided with a ring-type strain relief or means determined to be the equivalent shall not damage internal connections or components, or result in a reduction of electrical spacings.

11.6.1.3 Each lead used for field connections or an internal lead subjected to movement or handling during installation and servicing shall be capable of withstanding for 1 min a pull of 4.54 kg (10 lb) without any evidence of damage or of transmitting the stress to internal connections.

11.6.2 Supply Line Circuits

11.6.2.1 A lead provided for field connection to a circuit greater than 30 V rms or dc (42.4 peak) shall not be smaller than 18 AWG (0.82 mm²), and the insulation, when of rubber or thermoplastic, shall be minimum 1/32 in (0.8 mm) thick.

11.6.3 Circuits Less Than 30 V

11.6.3.1 A lead provided for field connection to a circuit less than 30 V shall be no smaller than 0.32 mm² (22 AWG) and the insulation shall be a minimum of 0.4 mm (1/64 in) thick.

Exception: Solid copper leads as small as 0.13 mm² (26 AWG) are to be used only when:

- A *The current does not exceed 1 A for lengths up to 61 cm (2 ft) or 0.4 A for lengths up to 3.05 m (10 ft);*
- B *There are two or more conductors and they are covered by a common jacket or the equivalent;*
- C *The assembled conductors comply with the strain-relief requirement specified in the Strain-Relief Test, Section 70; and*
- D *The installation instructions indicate that the lead shall not be spliced to a conductor larger than 0.82 mm² (18 AWG).*

11.7 CORDS AND PLUGS

11.7.1 Cords and cord connectors shall not be used for products not intended to be moved or relocated, or where the desirability of the product being readily detachable has not been demonstrated.

11.7.2 Cords and cord connectors shall be rated for the current and voltage used.

12 INTERNAL WIRING

12.1 GENERAL

12.1.1 The wiring and connections between parts of a product shall be protected or enclosed, or they shall be in a cord or cable that has been evaluated and determined to be rated for the application.

12.1.2 Internal wiring shall be routed and secured so that the wires and electrical connections are not subjected to stress or mechanical damage.

12.1.3 A hole in a wall within the overall enclosure of a product through which insulated wires pass, shall be provided with a bushing or shall have smooth, rounded surfaces.

12.1.4 Internal wiring shall be evaluated and determined to be rated for the application, with respect to temperature, voltage, ampacity, and exposure to oil, grease, solvents, acids, and other conditions of service to which the wiring is subjected.

12.1.5 When it is possible that internal wiring is to be exposed to moisture, including any condensation resulting from operation of the product, the wiring shall be evaluated and determined to be rated for such exposure.

12.1.6 Vibration, impact, flexing, or other movement of wires during intended use, including *user* servicing, shall not reduce the wire insulation or the wire termination integrity.

12.1.7 A lead or a cable assembly connected to a part mounted on a hinged cover shall be long enough to permit the full opening of the cover without applying stress to the lead or the connections. The lead shall be secured, or equivalently arranged, to reduce the risks of abrasion of the insulation and jamming of the leads between parts of the enclosure.

12.1.8 Metal clamps and guides used for routing stationary internal wiring shall be provided with smooth, well-rounded edges. Auxiliary nonconducting mechanical protection shall be provided:

- A Under a clamp at which pressure is exerted on a conductor having thermoplastic insulation less than 0.8 mm (1/32 in) thick and no overall braid; and
- B On any wire(s) that is subject to motion.

12.1.9 Wires shall be routed away from sharp edges (such as those found on screw threads, burrs, and fins), moving parts, and similar hazards, which tend to damage the wire insulation.

12.1.10 Insulated wires bunched and passed through a single opening in a metal wall within the enclosure of the product are not prohibited when the other requirements of this standard are met.

12.1.11 *Supplementary* insulation shall be applied to internal wiring that involves a *risk of electric shock* and is exposed during *user servicing*.

12.1.12 Internal wiring of circuits that operate 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 for the highest voltage.

12.1.13 Clamping, routing, or equivalent means that ensures permanent separation may accomplish segregation of insulated conductors.

12.2 SPLICES AND CONNECTIONS

12.2.1 All splices and connections shall be mechanically secure and shall be investigated and determined to provide intended electrical continuity. A soldered connection shall be made mechanically secure before being soldered. Consideration shall be given to vibration when investigating electrical connections. Pressure-wire connectors have been determined to comply with the requirements.

12.2.2 A splice shall be provided with insulation determined to be the equivalent to that of the wires involved when permanence of spacing between the splice and other metal parts is incapable of being maintained.

12.2.3 In determining whether or not splice insulation consisting of coated-fabric, thermoplastic, or another type of tape or tubing complies with the aforementioned requirements, a comparison is to be made of factors such as mechanical strength, dielectric properties, and heat- and moisture-resistant characteristics. Thermoplastic tape wrapped over sharp edges does not comply with the intent of this requirement.

12.2.4 When stranded internal wiring is connected to a wire-binding screw, there shall not be loose strands of wire that contact other uninsulated live parts or dead-metal parts. This shall be accomplished by use of pressure-terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other means that have been determined to be equivalent.

12.3 CONNECTORS AND RECEPTACLES

12.3.1 A receptacle or connector of the multiple-pin type shall be suitable for the current and voltage to which it is to be subjected.

13 PROTECTIVE DEVICES

13.1 A fuse holder, overcurrent protective device (other than an automatic control without a marked off position), the centre contact of a screwshell-base lampholder, an interlock, and a manual on-off switch with a marked off position shall be connected to the ungrounded side of the line when used in a circuit greater than 30 V.

13.2 A fuse holder shall be of either the cartridge-enclosed or plug-fuse type. The use of plug fuses is to be limited to equipment rated at not more than 125 V.

13.3 Fuse holders, fuses, and circuit breakers shall be rated for the application.

13.4 All *external circuits* intended to be connected to non-Class 2 wire shall contain either current-limiting or overcurrent protection to prevent *fault* currents in excess of the current rating for the gauge wire size permitted by the CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, or as specified in the installation wiring diagram/instructions. The overcurrent protection provided shall be as specified in CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations. See Clause 48.3.3.

13.5 In the installation wiring diagrams/instructions, it shall be noted that *supplementary* overcurrent protection shall not be used as a substitute for branch circuit overcurrent devices.

14 CURRENT-CARRYING PARTS

14.1 Except as noted in Clause 14.2, current-carrying parts shall be of silver, copper, a copper alloy, stainless steel, aluminum, or other nonferrous material intended for the application.

14.2 Plated steel meets the intent for some secondary-circuit or primary-circuit parts (such as capacitor terminals) when a glass-to-metal seat is necessary and for leads or threaded studs of semiconductor devices. Blued steel or steel with an equivalent corrosion resistance meets the intent for the current-carrying arms of mechanically or magnetically-operated leaf switches, and within a motor and motor governor including the motor terminals, or when the temperature is in excess of 100°C (212°F) during the intended operation.

14.3 Bearings, hinges, and the like shall not be used as current-carrying parts.

15 SPACINGS

15.1 A product shall provide maintained spacings between uninsulated live parts and the enclosure or dead-metal parts, and between uninsulated live parts of opposite polarity. The spacings shall not be less than those indicated in Table 10.

15.2 The through-air and over-surface spacings at an individual component part are to be determined on the basis of the volt-amperes used and controlled by the individual component. The spacing from one component to another, however, and from any component to the enclosure or to other uninsulated dead metal parts, shall be determined on the basis of the maximum voltage and total volt-ampere rating of all components in the enclosure.

15.3 The spacing requirements in Table 10 do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component which is provided as part of the control unit. Such spacings are determined 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 as specified in Table 10.

15.4 The "To-walls-of-enclosure" spacings indicated in Table 10 are not to be applied to an individual enclosure of a component part within an outer enclosure.

15.5 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material used where spacings would otherwise be insufficient, shall be minimum 0.71 mm (0.028 in) thick; except that a liner or barrier that is minimum 0.33 mm (0.013 in) thick meets the intent when used in conjunction with a minimum of one-half of the through-air spacing required. The liner shall be protected against arcing.

15.6 Insulating material having a thickness less than that specified in Clause 15.5 meets the intent when it has been determined to have equivalent mechanical and electrical properties.

15.7 Film-coated wire is identified as a bare current-carrying part in determining compliance of a device with the spacing requirements, but the coating is suitable as turn-to-turn insulation in coils.

15.8 The spacings within snap switches, lampholders, and similar wiring devices supplied as part of a unit are determined under other requirements for such devices and are not required to comply with the requirements of Table 10.

16 INSULATING MATERIAL

16.1 Uninsulated live parts involving *risk of fire*, electric shock, or electrical-energy/high-current levels shall be mounted on porcelain, phenolic composition, or other material that has been determined acceptable for the application.

16.2 Vulcanized fiber is not prohibited from being used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts when shrinkage, current leakage, or warpage introduces a *risk of fire*, electric shock, or injury to persons. Thermoplastic materials used for the direct or indirect support of uninsulated live parts involving a *risk of fire*, electric shock, or electrical-energy/high-current shall comply with the requirements in the CAN/CSA-C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials.

16.3 Molded parts shall have the mechanical strength and rigidity to withstand the stresses of actual service.

16.4 An insulating liner shall be investigated and determined to be rated for the purpose. Barriers shall be held in place by a means more secure than friction between surfaces. The elasticity of tubing shall not be depended upon to hold the tubing in place. Heat-shrink tubing has been determined to meet this requirement where a sharp edge or point is not involved.

17 PRINTED-WIRING BOARDS

17.1 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 requirements for Spacings, Section 15. The board shall be reliably mounted so that deflection of the board during installation or servicing shall not result in damage to the board or in developing a *risk of fire* or electric shock.

17.2 All printed-wiring boards shall have a minimum flammability rating of V-2, rated for direct support of current-carrying parts, and be suitable for the soldering process used.

18 END-OF-LINE DEVICES

18.1 An *end-of-line device* shall be constructed as follows:

- A Where the circuit in which the *end-of-line device* is to be connected is intended for connection by conduit or metal-clad cable, the device shall be arranged for mounting inside of a metal box to which such connection can be made. Mounting on an outlet box cover with terminals or leads provided for field connection, or an equivalent arrangement, has been determined as complying with the intent of this requirement;
- B Where the *end-of-line device* is intended to be installed inside a back box, splice leads, or terminals suitable for making field connections, shall be provided. Splice leads shall have a diameter of not less than 0.82 mm² (18 AWG). The exposed live parts of the assembly, except for the connection portion of the terminal, shall be covered with insulating tubing or the equivalent; and

C Where the *end-of-line device* is intended to be installed inside a product:

- 1) Splice leads or terminals suitable for making field connections shall be provided. Splice leads shall have a diameter not less than 0.82 mm². The exposed live parts of the assembly, except for the connection portion of the terminal, shall be covered with insulating tubing or the equivalent; or
- 2) It shall be provided with terminations compatible with the product's provisions for *field wiring* connections. When installed per the manufacturer's installation instructions, it shall be securely fastened with no means to open circuit, short to an adjacent circuit node, or cause a risk of electric shock. To avoid damage to the body of the *end-of-line device* during installation, the device shall be either supplied pre-formed or forming instructions shall be included in the installation instructions.

19 VOLTAGE-DROPPING RESISTORS

19.1 A carbon composition resistor shall not be used as a line voltage-dropping resistor in the circuit greater than 30 V, root-mean-square (rms), 42.4 V peak of a product.

20 COIL WINDINGS

20.1 Relays, transformers, and similar devices used in circuits greater than 30 V, 42.4 V peak shall be evaluated and rated for the intended purpose, or comply with the applicable requirements for the component (see Appendix A).

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

20.3 Film-coated wire is not required to have an additional treatment to prevent moisture absorption.

21 COMPONENTS

21.1 SWITCHES

21.1.1 A switch provided as part of a product shall have a current and voltage rating not less than that of the circuit which it controls when the device is operated under any condition of intended service.

21.2 LAMPHOLDERS AND LAMPS

21.2.1 Lampholders and lamps shall be rated for the circuit in which they are employed when the product is operated under any condition of intended service.

21.2.2 Except for circuits operating at 30 V, root-mean-square (rms), 42.4 V direct current (DC) or 42.4 V peak, or less, 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.

21.2.3 The colour coding of lamps or equivalent indicators employed as part of a product shall not be the sole means of identifying the function of the indicator.

Exception: Lamps and indicators used by service personnel for diagnostic purposes, provided that they are identified in the product's installation instructions/manual.

21.3 OPERATING MECHANISMS

21.3.1 Operating parts, such as light-duty relays and similar devices, shall be protected against fouling by dust or by other material that may adversely affect their intended operation, by individual protection or dust-tight cabinets. A relay employing contacts having a wiping action does not require any special protection against fouling by dust.

21.3.2 The assembly of an operating mechanism included as a part of a control unit or accessory shall be such that it will not be adversely affected by any condition of intended operation.

21.3.3 Moving parts shall have sufficient play at bearing surfaces to prevent binding.

21.3.4 Provision shall be made to prevent adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

21.3.5 Manually-operated parts shall withstand the stresses to which they will be subjected in operation.

21.3.6 An electromechanical device shall be constructed to provide reliable and positive electrical and mechanical performance under all conditions of intended operation.

21.4 ACROSS-THE-LINE COMPONENTS

21.4.1 Components such as capacitors and EMI filters, connected across the supply circuits greater than 30 V, root-mean-square or 42.4 V peak of a product, shall be rated for the purpose or comply with the applicable requirements for the component. See Appendix A.

21.4.2 A component is considered to be across the supply circuit greater than 30 V, root-mean-square or 42.4 V peak when, in a shorted condition, a current of more than 1 A passes through it when the product is in any condition where the individual components have reached ultimate operating temperatures. The current through the component can be limited to 1 A or less by a fixed impedance or a protective device rated 1 A or less.

21.4.3 A capacitor is also considered to be across-the-line when it is used under either of the following conditions:

- A For supply-line circuits greater than 30 V rms, or 42.4 V peak bypass in equipment provided with a terminal or connection intended to be grounded; or
- B For antenna blocking or supply-line bypass circuits greater than 30 V, root-mean-square or 42.4 V peak in equipment provided with one or more external antenna terminals that may be grounded.

22 BATTERIES

22.1 RECHARGEABLE STORAGE-TYPE USED AS A SECONDARY POWER SOURCE

22.1.1 A *storage battery* shall have sealed cells, or cells with spray trap vents, and shall be maintained in the charged state.

22.1.2 Batteries shall be located and mounted so that terminals of cells are prevented from coming into contact with terminals of adjacent cells or with metal parts of the battery enclosure as a result of shifting of the batteries.

22.1.3 The mounting arrangement for the batteries shall permit access to the cells for testing and maintenance, or the product shall provide integral meters or readily accessible terminal facilities for the connection of meters for determining battery voltage and charging current.

22.1.4 A conditioning charge shall be limited so that, with the maximum rate of charge that can be obtained, the battery gases do not adversely affect any part of the product. The trickle and fast charge rates of a battery shall not exceed the battery manufacturer's recommended rates.

22.1.5 The battery shall be protected against excessive loading or charging current by a fuse or other overcurrent protective device.

22.2 PRIMARY DRY-CELL BATTERIES

22.2.1 When a battery or set of batteries is used as the main source or the non-rechargeable standby source of power of a product, it shall meet the requirements of the Primary Batteries Tests, Section 69.

22.2.2 Batteries shall be located and mounted to reduce the risk of terminals of cells coming in contact with uninsulated live parts, terminals or adjacent cells, or metal parts of the enclosure as a result of shifting.

22.2.3 Ready access shall be available to the battery compartment to facilitate battery replacement, without damage to the product components or disassembly of any part of the product, except for a cover or similar parts.

22.2.4 Removal of the product from a mounting support to replace a battery shall be permitted only where the connected wiring is not subjected to flexing or stress and the mounting of the product is supervised.

22.2.5 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and strain relief provided for any leads. The polarity shall be indicated on the product either adjacent to the battery terminals or leads.

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

22.2.7 Each lead of a clip lead assembly used as part of a battery operated product shall be suited for the intended application, shall be minimum 0.21 mm² (26 AWG) stranded wire size with minimum 0.4 mm (1/64 in) insulation and provided with strain relief.

22.3 LITHIUM BATTERIES

22.3.1 Lithium batteries shall comply with the requirements in the Standard for Lithium Batteries, UL 1642.

22.3.2 A lithium battery shall be protected from abnormal charging currents during use as required in the Standard for Lithium Batteries, UL 1642.

Exception: A circuit that obtains power solely from a lithium battery (for example, a circuit in which the lithium battery serves as the sole power source as opposed to serving as a standby power source) is not required to be subjected to the abnormal charging current requirements in UL 1642.