



**GUIDE
FOR
THE INVESTIGATION
OF
ANTITHEFT ALARMS AND DEVICES**

UNDERWRITERS' LABORATORIES OF CANADA

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GUIDE
FOR
THE INVESTIGATION
OF
ANTITHEFT ALARMS AND DEVICES

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ULC Subject C1037-M88

**GUIDE
FOR
THE INVESTIGATION
OF
ANTITHEFT ALARMS AND DEVICES**

FOREWORD

This is the First Edition of ULC Subject C1037, entitled "Guide for the Investigation of Antitheft Alarms and Devices".

A product which complies with these requirements will not necessarily be acceptable, if, when examined and tested, it is found to have features not covered by the Guide which may impair the result contemplated by these requirements.

A product employing materials or having forms of construction differing from those detailed in these requirements may be examined and tested according to the intent of the requirements, and if found to be substantially equivalent, may be given recognition.

Only SI Units of measurement are used in this Guide. Imperial equivalents of the most commonly used metric units may be determined by referring to the conversion factors itemized on the Table located inside the back cover.

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GENERAL

1. Scope

1.1 These requirements apply to the construction, performance and operation of equipment intended to provide antitheft protection.

1.2 An antitheft alarm is intended to give both audible and visible signals or only an audible signal if theft of protected property is attempted.

1.3 An antitheft device is intended to protect property by significantly limiting the mobility or portability of the property.

2. Glossary

2.1 For the purpose of these requirements, the following definitions apply.

2.2 CIRCUITS, ELECTRICAL:

A HIGH-VOLTAGE - A circuit involving a potential of not more than 300 V and having circuit characteristics in excess of those of a low-voltage power limited circuit.

B LOW-VOLTAGE (Power Limited) - A circuit involving a potential of not more than 30 V rms (42.4 V peak) and providing not more than 100 VA rated output. The power limitation shall be provided by the construction of the transformer, a fixed impedance, a non-interchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

2.3 CORD-CONNECTED UNIT - A unit intended for connection to the power source by means of a supply cord. By the nature of its construction, such a unit is intended to be moved for reasons of interchange or realignment of the units of a system.

2.4 LINE-VOLTAGE - The voltage at any field connected source of supply, nominally 50 to 60 Hz; 115, 208, or 230 V.

2.5 NORMAL STANDBY CONDITION - The ready-to-operate condition which exists prior to being tripped or operated by an attempted theft.

2.6 RADIO FREQUENCY - Electromagnetic radiation normally 20 kilohertz (kHz) or higher.

2.7 "SAFETY" CIRCUIT - Any circuit that is relied upon to reduce the risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons (an interlock circuit, for example).

2.8 SECONDARY BATTERY - Any battery which, by construction, is intended to be recharged.

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3. General

3.1 The term "product" as used in this Guide refers to all types of antitheft alarms and devices.

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

4. Installation and Operating Instructions

4.1 A copy of the installation and operating instructions intended to accompany the product and related schematic wiring diagrams and installation drawings are to be furnished with the sample submitted for investigation to be used as a guide in the examination and test of the product, and for this purpose need not be in final printed form.

4.2 The instructions and drawings shall include at least the following:

- A Typical installation drawing layouts and complete representative installation wiring diagram(s) for the product(s) indicating recommended locations and wiring methods which shall be in accordance with the Canadian Electrical Code, Part I. Locations where installations are not recommended shall also be included;
- B A concise description of the operation, testing, and maintenance procedures for the product(s), and recommended testing frequency (which shall be at least once per year);
- C Replacement parts, such as lamps or batteries, shall be identified in the instructions by a part number, manufacturer's model number, or the equivalent;
- D A description of the conditions which might be expected to result in false alarms or impaired operation of the product(s); and
- E A description of any features provided to protect against electric shock or risk of fire, and a warning against bypassing such features.

4.3 The instructions may be incorporated on the inside of the product, on a separate sheet, or as part of a manual. If not included directly on the product, the instructions or manual shall be referenced in the marking information on the product. See Marking, Section 66.

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CONSTRUCTION

ASSEMBLY

5. General

Product Assembly

5.1 The product shall be factory-built as a complete assembly and shall include all the essential components necessary for its intended function when installed (used) as intended. The product may be shipped from the factory as two or more major subassemblies. See Clause 5.2.

5.2 If the product is not assembled by the manufacturer as a complete unit, it shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated into a final assembly without requiring alteration, cutting drilling, threading, welding, or similar tasks by the installer. Two or more subassemblies, which must bear a definite relationship to each other for the correct installation or operation of the product, shall be arranged and constructed to permit them to be incorporated into the complete assembly only in the correct relationship with each other without the need for alteration or alignment, or such subassemblies shall be assembled, tested, and shipped from the factory as one element.

Electrical Protection

5.3 Louvers and other openings in the enclosure shall be constructed and located to prevent unintentional contact with uninsulated high-voltage live parts. In determining compliance with this requirement, parts such as covers, panels and grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided.

5.4 Uninsulated high-voltage live parts shall be located, guarded, or enclosed as indicated in Clauses 5.5 to 5.7.

5.5 Openings directly over uninsulated high-voltage live parts shall not exceed 5 mm in any dimension unless the configuration is such that direct entry to uninsulated high-voltage live parts is prevented. See also Clause 7.9.

5.6 An opening in an electrical enclosure shall not permit entrance of a 25 mm diameter rod and shall be sized and so arranged that a probe, as illustrated in Figure 1, cannot be made to contact any uninsulated live electrical part (other than low-voltage) when inserted through the opening in a straight or articulated position.

5.7 An opening that permits entrance of a 25 mm diameter rod is acceptable under the conditions described in Figure 2.

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6. Protection of Service Personnel

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

6.2 During the examination of a product in connection with the requirements in Clause 6.1, a part of the outer enclosure which may be removed without the use of tools, or part of the outer enclosure which may be removed by the user to allow access for making normal operating adjustments, is to be disregarded; that is, it will not be assumed that the part in question affords protection against electric shock.

6.3 An electrical component which may require examination, replacement, adjustment, servicing, or maintenance with the product energized shall be located and mounted with respect to other components and with respect to grounded metal so that it is accessible for such service without subjecting the serviceman to the likelihood of electric shock from adjacent uninsulated high-voltage live parts.

6.4 The following are not considered to be uninsulated live parts: coils of relays and solenoids, and transformer windings, if the coils and windings are provided with insulating over-wraps rated for the potentials encountered; terminals and splices with insulation rated for the potential encountered; and insulated wire.

7. Enclosures

General

7.1 The frame and enclosure of a product shall have the strength and rigidity to resist total or partial collapse and the attendant reduction of spacings, loosening or displacement of parts, or other defects. See Mechanical Strength Tests for Enclosures, Section 49.

7.2 Operating parts, such as gear mechanisms, light-duty relays, and similar devices, shall be enclosed to protect against malfunction from dust or from other material which may impair their intended operation.

7.3 An enclosure containing other than power limited circuits shall be constructed to minimize the possibility of emission of flame, molten metal, flaming or glowing particles, or flaming drops. See Ignition Through Bottom-Panel Openings Tests, Section 48.

7.4 The requirement in Clause 7.3 necessitates either a nonflammable bottom in accordance with Clause 7.10, or a protective barrier as described in Figure 3 under all areas containing combustible materials.

EXCEPTION: See Clause 7.11.

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7.5 A construction employing individual barriers under components, groups of components, or assemblies, as specified in Figure 3 is to be considered as complying with the requirement in Clause 7.3.

7.6 The enclosure of a product having provision for installation wiring by means of conduit openings shall be in accordance with Clauses 7.18 to 7.20, Cast Metal; 7.23 to 7.26 (inclusive), Sheet Metal; and 7.29 to 7.34 (inclusive), Polymeric Materials.

Doors and Covers

7.7 An enclosure cover shall be hinged, sliding, or similarly attached so as to prevent its being removed if it gives access to fuses or any other overcurrent protective device, the intended functioning of which requires renewal, or if it is necessary to open the cover in connection with the intended operation of the unit.

EXCEPTION: If its position is supervised by a tamper contact which is connected in the closed protective circuit, an enclosure need not comply with the requirements of this clause. See also Clause 29.5.

7.8 Fasteners requiring the use of a tool or key shall be used for all enclosures if access is not required for operation of the product.

NOTE: A coin is not a tool.

Enclosure Openings

7.9 Openings in the enclosure shall be so constructed and of such size that direct entry of foreign objects is prevented. See also Clause 5.5. See Figure 4 for examples of top cover designs that are deemed to prevent direct entry. See also Figure 5 for side openings.

7.10 Openings may be provided in the bottom panels or protective pans under areas containing materials not classified as 0.6V-1, in accordance with the CSA Standard C22.2 No. 0.6-M1982, Flammability Testing of Polymeric Materials, if constructed in a manner that prevents materials from falling directly from the interior of the product onto the supporting surface or any other location under the product. Figure 6 illustrates a type of baffle that meets this requirement. A second construction that meets this requirement is a 1.02 mm sheet-steel bottom panel in which 1.0 mm maximum, round holes are spaced no closer together than 3 mm centre-to-centre. Constructions other than these two are acceptable if they comply with the Ignition Through Bottom-Panel Openings Tests, Section 48.

7.11 The bottom of the enclosures under areas containing only materials classified as 0.6V-1 or better, may have openings not larger than 40 mm².

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7.12 Openings are acceptable, without limitation of the size or number of openings, in areas containing only PVC, TFE, CTFE, FEP, and neoprene insulated wire or cable, in areas containing plugs and receptacles, and in areas underneath impedance protected or thermally protected motors.

7.13 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that might be subject to tampering by hand or with tools.

Screens and Expanded Metal

7.14 Screens and expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements of Clauses 7.15 through 7.17 and with the Mechanical Strength Tests for Enclosures, Section 49.

7.15 Perforated sheet steel and sheet steel employed for expanded metal mesh shall be not less than 1.07 mm in thickness [1.17 mm if zinc coated] if the mesh openings or perforations are 320 mm² or less in area, and shall be not less than 2.03 mm in thickness [2.13 mm if zinc coated] for larger openings. The largest dimension shall not exceed 100 mm.

7.16 Where the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values (see Spacings, General, Section 22), 0.53 mm expanded steel mesh or perforated sheet steel [0.58 mm if zinc coated] may be employed, provided that the exposed mesh on any one side or surface of the product is protected has an area of not more than 465 mm² and has no dimension greater than 300 mm, or that the width of an opening so protected is not greater than 90 mm.

7.17 The wires of a screen shall be not less than No. 16 AWG steel if the screen openings are 320 mm² or less in area, and shall be not less than No. 12 AWG steel for larger screen openings.

Cast Metal

7.18 The thickness of cast metal for an enclosure shall be as indicated in Table 1, except that 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 Drop Test, Section 26; and Mechanical Strength Tests for Enclosures, Section 49.

7.19 If threads for the connection of conduit are tapped through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be not less than 3-1/2 nor more than five threads in the metal, and the construction shall be such that a standard conduit bushing can be attached as intended.

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TABLE 1

CAST-METAL ENCLOSURES

Use, or Dimensions of Area Involved ^a ,	Minimum Thickness	
	Die-Cast Metal, Millimetres	Cast Metal of Other Than the Die-Cast Type, Millimetres
Area of 155 cm ² or less and having no dimension greater than 150 mm	1.6	3.2
Area greater than 155 cm ² or having any dimension greater than 150 cm	2.5	3.2
At a threaded conduit hole	7.0	7.0
At an unthreaded conduit hole	3.2	3.2
^a The area limitation for metal 1.6 mm in thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.		

7.20 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 3-1/2 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 the provided by a standard conduit bushing.

Sheet Metal

7.21 The thickness of sheet metal for an enclosure shall be not less than that indicated in Table 2 or 3, whichever applies, except that 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, Section 49 and Drop Tests, Section 26.

7.22 A sheet metal member to which a wiring system is to be connected in the field shall have a thickness of not less than 0.81 mm if of uncoated steel, of not less than 0.86 mm if of galvanized steel, and of not less than 1.14 mm if of nonferrous metal.

7.23 A plate or plug closure for an unused conduit opening or other hole in the enclosure shall have a thickness not less than 0.70 mm if of steel or 0.80 mm if of nonferrous metal for a hole having a 35 mm maximum diameter.

T A B L E 2

**MINIMUM THICKNESS OF SHEET METAL FOR ENCLOSURES
CARBON STEEL OR STAINLESS STEEL**

Without Supporting Frame ^a		With Supporting Frame or Equivalent Reinforcing ^a		Minimum Thickness	
Maximum Width ^b , Millimetres	Maximum Length ^c , Millimetres	Maximum Width ^b , Millimetres	Maximum Length ^c , Millimetres	Uncoated, Millimetres	Metal Coated Millimetres
102	Not limited	159	Not limited		
121	146	172	210	0.52	0.59
152	Not limited	241	Not limited		
178	222	254	318	0.68	0.75
203	Not limited	305	Not limited		
229	292	330	406	0.78	0.88
318	Not limited	495	Not limited		
356	457	533	635	1.02	1.16
457	Not limited	686	Not limited		
508	635	737	914	1.34	1.43
559	Not limited	838	Not limited		
635	787	889	1092	1.52	1.62
635	Not limited	990	Not limited		
737	914	1041	1295	1.69	1.79
838	Not limited	1295	Not limited		
889	1194	1372	1676	2.00	2.14
1067	Not limited	1626	Not limited		
1194	1500	1727	2134	2.30	2.47
1321	Not limited	2032	Not limited		
1524	1880	2134	2616	2.73	2.85
1600	Not limited	2464	Not limited		
1854	2286	2616	3226	3.11	3.23

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles of channels. Construction considered to be without supporting frame includes a single sheet with single formed flanges (formed edges), or a single sheet which is corrugated or ribbed, or an enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 12.5 mm wide.

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T A B L E 3

**MINIMUM THICKNESS OF SHEET METAL FOR ENCLOSURES
ALUMINUM, COPPER OR BRASS**

Without Supporting Frame ^a		With Supporting Frame or Equivalent Reinforcing ^a		
Maximum Width ^b , Millimetres	Maximum Length ^c , Millimetres	Maximum Width ^b , Millimetres	Maximum Length, Millimetres	Maximum Thickness Millimetres
76	Not limited	178	Not limited	0.58
89	102	216	241	
102	Not limited	254	Not limited	0.74
127	152	267	343	
152	Not limited	356	Not limited	0.91
165	203	281	457	
203	Not limited	483	Not limited	1.14
241	292	533	635	
305	Not limited	711	Not limited	1.47
356	406	762	940	
457	Not limited	1067	Not limited	1.91
508	635	1143	1397	
635	Not limited	1524	Not limited	2.41
737	914	1627	1981	
940	Not limited	2210	Not limited	3.10
1067	1346	2362	2896	
1321	Not limited	3124	Not limited	3.89
1524	1880	3302	4064	

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles of channels. Construction considered to be without supporting frame includes a single sheet with single formed flanges (formed edges), or a single sheet which is corrugated or ribbed, or an enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 12.5 mm wide.

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7.24 A closure for a hole larger than 35 mm diameter shall have a thickness equal to that required for the enclosure of the product or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

7.25 A knockout in a sheet metal enclosure shall be capable of being removed without excess deformation of the enclosure.

7.26 A knockout shall be provided with a surrounding surface of sufficient area to provide for seating of a conduit bushing and shall be located so that installation of a bushing 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 specified under (Spacings) General, Section 22.

Product Enclosure Mounting

7.27 An enclosure shall have means for mounting which shall be accessible without disassembly of any operating part of the product. Removal of a completely assembled panel to mount the enclosure is not considered to be disassembly of an operating part.

Polymeric Materials

7.28 Among the factors taken into consideration when judging the acceptability of nonmetallic enclosure are: the mechanical strength; resistance to impact; moisture-absorptive properties; flammability and resistance to ignition from electrical sources; dielectric strength, insulation resistance, and resistance to arc tracking; and resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use. All these factors are considered with respect to aging in accordance with the Polymeric Materials Test, Section 45, and Mechanical Strength Tests for Enclosures, Section 49.

7.29 A connection box or similar compartment having provisions for conduit connection of installation wiring, and a suitable grounding terminal means, shall be provided.

7.30 The metal plate to which conduit or armoured cable is attached shall be suitable for the conduit or cable to be secured, but in any case, if of sheet steel shall be not less than 0.75 mm thick and not less than 1.09 mm thick if of nonferrous metal.

7.31 A plate or plug closure for an unused conduit opening or other hole in the connection box or similar compartment shall have a thickness not less than:

A 0.36 mm for steel or 0.48 mm for nonferrous metal for a hole having a maximum dimension of 6.4 mm;

B 0.69 mm for steel or 0.81 mm for nonferrous metal for a hole having a maximum dimension of 35 mm.

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7.32 A hole larger than 35 mm diameter shall have a closure whose thickness is not less than that required for the connection box or similar compartment or shall have a standard knockout seal. Such plates or plugs shall be securely mounted.

7.33 A knockout in the connection box or similar compartment shall be secured but shall be capable of being removed without undue deformation of the connection box or compartment.

7.34 A knockout shall be provided with a surrounding surface area of sufficient size to permit seating of a conduit bushing, and shall be so located 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 Subsection 22, Spacings.

Electric Shock

7.35 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Section 34.

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

7.37 The conductive connection specified in Clause 7.36 need not be provided if such a connection is established in the event of electrical breakdown of the antenna isolating means, or the breakdown does not result in a risk of electric shock and in a construction employing an isolating power transformer, or the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.

7.38 The maximum value of 5.2 megohms specified in Clauses 7.36 and 7.37 is to include the maximum tolerance of the resistor value use; that is, a resistor rated 4.2 megohms with 20% tolerance or a resistor rated 4.7 megohms with a 10% tolerance is acceptable. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated a minimum of 1/4 W.

7.39 The insertion in any socket of any plug-in component used in the product shall not result in a risk of electric shock.

8. Corrosion Protection

8.1 Iron and steel parts, other than bearings, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means. Bearing surfaces shall be of such materials and construction as to resist binding due to corrosion.

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8.2 The requirement of Clause 8.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

EXCEPTIONS: This requirement does not apply to parts, such as washers, screws, bolts, and the like, if corrosion of such unprotected parts would not be likely to result in a risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons or to impair the operation of the unit.

Parts made of stainless steel, polished or treated, if necessary, do not require additional protection against corrosion.

8.3 Metals used in cabinets and enclosures shall be galvanically compatible. This requirement does not apply if galvanic action does not result in malfunction of the product, risk of fire, electric shock, or unintentional contact with moving parts that can cause injury to persons.

8.4 Hinges and other attachments shall be resistant to corrosion.

FIELD WIRING CONNECTIONS

9. General

9.1 Wiring terminals or leads shall be provided for connection of conductors of at least the size required by the Canadian Electrical Code, Part 1.

10. Cord Connected Products

10.1 A cord connected product that is intended to be connected to high-voltage or line voltage shall be provided with no less than 1800 mm of flexible cord with a grounding conductor and a three prong attachment-plug of acceptable type and rating for connection to the supply circuit and shall be in compliance with application requirements in CSA Standard C22.2, No. 21, Cord Sets and Power-Supply Cords.

EXCEPTION: A cord may be less than 1800 mm in length if it is evident that the use of a longer cord may result in damage to the cord or product, or result in a risk of fire, electric shock, or injury to persons, or is not required for the intended operation of the product.

10.2 A flexible cord is acceptable for use with a stationary product.

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10.3 A flexible cord shall be of Type SJ, SJT, or equivalent and shall be not smaller than No. 18 AWG. It shall be rated for use at the voltage and current rating of the product.

10.4 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 47.

10.5 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, which may cause abrasion of the insulation on the conductors.

10.6 Clamps of any material (metal or otherwise) are acceptable for use on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

10.7 The supply cord or supply leads shall be prevented from being pushed into the unit through the cord-entry hole if such displacement is likely to subject the cord or supply leads to mechanical damage or to exposure to a temperature higher than that for which the cord or supply leads are suitable or is likely to reduce spacings (such as to a metal strain-relief clamp) below the minimum acceptable values or is likely to damage internal connections or components.

11. Permanently Connected Products

General

11.1 A fixed product shall have provision for connection of one of the wiring systems that, in accordance with the Canadian Electrical Code, Part 1, would be suitable for it.

11.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the size required by the Canadian Electrical Code.

11.3 The location of a terminal box or compartment in which power supply connections are to be made shall be such that the connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

11.4 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be prevented from turning.

11.5 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the product. It is assumed that branch circuit conductors rated 60°C will be used.

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Field Wiring Terminals

General

11.6 As used in these requirements, field-wiring terminals are those terminals to which power supply (including equipment grounding) or control connections will be made in the field when the product is installed.

11.7 A field-wiring terminal shall be prevented from turning or shifting in position. This may be accomplished by means such as two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part. Friction between surfaces is not acceptable for preventing movement of the terminals.

General Application

11.8 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for No. 8 AWG and larger wires. If the connectors or lugs are secured to a plate, the plate thickness shall be not less than 1.3 mm. Securing screws may be plated steel.

11.9 A wire binding screw intended for connection of the power supply (line voltage) source shall be not smaller than No. 10. The screw may be of plated steel.

EXCEPTION: A No. 8 screw may be used for the connection of one No. 14 AWG and a No. 6 screw may be used for the connection of a No. 16 AWG or smaller conductor.

11.10 For connection of other than power supply (line voltage) circuits using No. 10 AWG and smaller wires, a wire binding screw shall be not smaller than No. 8, except that a No. 6 screw may be employed for the connection of a No. 14 AWG or smaller conductor and a No. 4 screw may be used for a No. 19 AWG or smaller conductor.

11.11 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 employed if they provide equivalent thread security of the wire binding screw.

B Be of a nonferrous metal not less than 1.3 mm in thickness for a No. 8 or larger screw, and not less than 0.76 mm in thickness for a No. 6 or smaller screw.

11.12 If two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be employed for each additional conductor. A separator washer is not required if two conductors are separated and intended to be secured under a common clamping plate. If the wires protrude above terminal barriers, the nonferrous separator shall include means, such as upturned tabs or sides, to retain the wire.

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Qualified Application

11.13 Any of the following terminal configurations may be employed for connection of field wiring provided all of the conditions in Clause 11.14 are met:

- A Telephone Type Terminals - Nonferrous terminal plates employing a narrow V-shaped slot for securing of a conductor in a special post design. Requires special tool for wire connection;
- B Solderless Wrapped Terminals - Solderless wrapped nonferrous terminals which require a special tool and terminal post construction;
- 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. Requires special tool for crimping of field wires. Mating terminals shall be shipped with the product with instructions for their installation;
- D Push-In Terminals - Nonferrous (screwless) push-in terminals of the type employed on some switches and receptacles. Solid conductors are pushed into slots containing spring type contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals are not considered suitable for use with aluminum conductors. The marking adjacent to the terminal shall indicate that copper conductors only are to be used;
- E Solder Terminals - Conventional nonferrous solder terminals; and
- F Other Terminals - Other terminal connections may be employed if found to be equivalent to items A through E of this Clause and limited to the same restrictions.

11.14 Any of the terminal configurations listed in Clause 11.13 may be employed for connection of field wiring provided all of the following indicated conditions are met:

- A If a special tool is required for connection, its use shall be indicated on the installation wiring diagram by name of manufacturer and model number of equivalent, along with information as to where the tool may be obtained;
- B The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size to be employed shall be not less than No. 22 AWG;
- C The wire size to be employed shall have the current-carrying capacity for the circuit application; and
- D The terminal configuration shall comply with the requirements of the Special Terminal Assemblies Tests, Section 50.

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Field Wiring Leads

11.15 If leads are provided in lieu of wiring terminals, they shall be not less than 150 mm long, and shall be not smaller than No. 22 AWG.

EXCEPTION: The lead may be less than 150 mm in length if it is evident that the use of a longer lead may result in damage to the lead insulation or product, or result in an electric shock, a risk of fire or accident, or is not required for the intended operation of the product.

11.16 For connection of a line-voltage source, the leads shall be not smaller than No. 18 AWG.

11.17 Leads intended for connection to an external circuit shall be provided with a strain relief means if stress on the lead may be transmitted to terminals, splices or internal wiring. (See Strain Relief Test, Section 47.)

Polarity Identification

11.18 In a product intended to be connected to a grounded circuit, one terminal or lead shall be identified for the connection of the grounded conductor. The identified terminal or lead shall be the one which is connected to the screw shells of lampholders and to which no primary overcurrent-protective devices of the single-pole are connected.

11.19 A terminal intended for the connection of grounded supply conductor shall be composed of or plated with metal that is substantially white in colour and shall be distinguishable from the other terminals, or identification of the terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or natural gray colour and shall be distinguishable from the other leads.

12. Grounding

12.1 A grounding means shall be provided for all equipment containing parts which require grounding. See Bonding for Grounding, Section 16.

12.2 The following are considered to constitute means for grounding:

- A In a product intended to be permanently connected by a metal enclosed wiring system, a knockout or equivalent opening in the metal enclosure of the product;
- B In a product intended to be permanently connected by a nonmetallic enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead; and
- C In a cord-connected product, an equipment grounding conductor in the cord.

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12.3 On a permanently-connected product, a terminal intended solely for the connection of an equipment grounding conductor shall be capable of securing a conductor of the size suitable for the particular application in accordance with the Canadian Electrical Code, Part 1.

12.4 A soldering lug, a push-in, a screwless connector, or a quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord.

12.5 On a permanently-connected product, a wire binding screw intended for the connection of an equipment grounding conductor shall have a green coloured head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified such as by being marked "G", "GR", "GROUND" or "GROUNDING", or the like, or by a marking on a wiring diagram provided on the product. See also Clause 12.6. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the product and shall be located so that it is unlikely to be removed during service operations such as replacing fuses, resetting manual-reset devices, or the like.

12.6 If a pressure wire connector intended for grounding is located where it could be mistaken for a neutral conductor of a grounded supply, it shall be identified by a marking "EQUIPMENT GROUND" and/or with a green colour identification.

12.7 On a permanently-connected product, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green colour or a continuous green colour with one of more yellow stripes, and no other lead shall be so identified.

12.8 On a cord-connected product, the grounding conductor of the flexible cord shall be finished with a continuous green colour or with a continuous green colour with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the product by a positive means, see Bonding or Grounding, Section 16, that is not likely to be removed during any servicing operation not involving the power supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

INTERNAL WIRING

13. General

13.1 Internal wiring shall have thermoplastic or rubber insulation not less than 0.4 mm thick for 0 to 300 V applications if: power is less than 375 VA; current is less than 5 A; and the wiring is not subject to flexing or mechanical abuse. Otherwise, thermoplastic or rubber insulation not less than 0.8 mm thick and rated 300 V shall be used. Other insulating material of lesser thickness may be used if it is equivalent.

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13.2 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 equivalently arranged to prevent abrasion of insulation and jamming between parts of the enclosure.

13.3 Insulation, such as coated fabric and extruded tubing, shall not be affected physically or electrically by the temperature or other environmental conditions to which it may be subjected in intended use.

13.4 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. Holes in sheet metal walls through which insulated wires pass shall be provided with a bushing if the wall is 1.07 mm or less in thickness. Holes in walls thicker than 1.07 mm shall have smooth, rounded edges.

14. Wiring Methods

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

14.2 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged.

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

14.4 A printed-wiring assembly employing insulating coatings or encapsulation shall be tested for dielectric voltage withstand before and after being treated. If it is impractical to use untreated samples, finished samples shall be subjected to the Dielectric Voltage Withstand Test, Section 40, after they are subjected to the Humidity Test, Section 33; Temperature Test, Section 41, and other applicable tests described in this Guide.

14.5 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent which shall provide a smooth, rounded surface against which the cord may bear.

14.6 If the cord hole is in phenolic composition or other nonconducting material, or in metal not less than 1.07 mm in thickness, a smooth, rounded surface is considered to be the equivalent of a bushing.

14.7 Ceramic materials and some moulded compositions are acceptable for insulating bushings.

14.8 Fibre may be employed where it will not be subjected to a temperature higher than 90°C under intended operating conditions if the bushing is not less than 1.2 mm in thickness and if it will not be exposed to moisture.

14.9 A soft rubber bushing may be employed in the frame of a motor if the bushing is not less than 1.2 mm in thickness and if the bushing is so located that it will not be exposed to oil, grease, oily vapor, or other substance 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 would be likely to cut into the rubber.

14.10 An insulating-metal grommet may be considered to be acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 0.8 mm in thickness and completely fills the space between the grommet and the metal in which it is mounted.

15. Separation of Circuits

15.1 Internal wiring of circuits which operate at different potentials shall be separated by barriers, clamps, routing, or other equivalent means, unless all conductors are provided with insulation which is rated for the highest potential involved.

15.2 If a barrier is used to provide separation between the wiring of different circuits, it shall be of metal or of insulating material. A barrier of insulating material shall be not less than 0.71 mm thick. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1.6 mm.

16. Bonding for Grounding

16.1 In a high-voltage product, provision shall be made for the grounding of all exposed or accessible noncurrent-carrying metal parts which are likely to become energized and which may be contacted by the operator or by service personnel during service operations likely to be performed when the product is energized.

16.2 Uninsulated metal parts, such as cabinets, electrical enclosures, capacitors and other electrical components, are to be bonded for grounding if they may be contacted by the operator or serviceman, except as indicated in Clause 16.3.

16.3 Metal parts described as follows need not be grounded:

- A Adhesive-attached metal-foil markings, screws, handles, and the like, which are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized;
- B Insolated metal parts, such as small assembly screws, which are positively separated from wiring and uninsulated live parts;
- C Cabinets, panels and covers which do not enclose uninsulated live parts if wiring is positively separated from the cabinet, panel or cover so that it is not likely to become energized; and

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- D Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fibre, varnished cloth, phenolic composition, or similar materials not less than 0.71 mm in thickness, and secured in place. If material having a lesser thickness is used, consideration is to be given to such factors as its electrical, mechanical and flammability properties when compared with materials in thicknesses specified above.

16.4 The metal enclosure of a product having a slide-out chassis is considered to be grounded if the resistance between the point of connection of the equipment grounding means and enclosure does not exceed 0.1 ohm. Unless a separate grounding conductor is used, this will require that all non-conductive coatings between the enclosure and equipment grounding means be penetrated when the chassis is inserted in the enclosure. In such cases, metal-to-metal contact must be maintained at any point of insertion or withdrawal of the chassis.

16.5 Metal-to-metal hinge bearing members for a door or cover are considered to be a means for bonding a door or cover for grounding if a minimum of two pin-type hinges with a minimum of three knuckles each are employed.

16.6 A separate component bonding conductor shall be of copper, a copper alloy or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or non-metallic coatings, such as enameling, galvanizing or plating. A separate bonding conductor or strap shall be protected from mechanical damage or be located within the confines of the outer enclosure or frame, and not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

16.7 The bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point greater than 445°C. The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material.

EXCEPTION: See Clause 16.10

16.8 With reference to Clause 16.7, a bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

16.9 An internal connection for bonding internal parts to the enclosure for grounding, but not for a field installed grounding conductor or for the grounding wire in a supply cord, and employ a quick-connect terminal of the specified dimensions if the connector is not likely to be displaced and the component is limited to use on a circuit having a branch circuit protective device, rated as follows:

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<u>Terminal Dimensions, Millimetres</u>	<u>Rating Protective Device, Amperes</u>
0.51 by 4.75 by 6.4	20 or less
0.81 by 4.75 by 6.4	20 or less
0.81 by 5.2 by 6.4	20 or less
0.81 by 6.4 by 7.9	60 or less

16.10 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be acceptable if it complies with Clause 16.14 under any normal degree of compression permitted by a variable clamping device and if the results are still acceptable after exposure to the effects of oil, grease, moisture, and thermal degradation which may occur in service. Also, the effect of assembling and disassembling such a clamping device for maintenance purposes is to be considered, with particular emphasis on the likelihood of the clamping device being reassembled in its intended fashion.

16.11 On a cord-connected product, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord.

EXCEPTION: See Clauses 16.14 and 16.15.

16.12 On a permanently-connected product, the size of a conductor employed to bond an electrical enclosure shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected.

16.13 A conductor, such as a clamp or strap, used in place of a separate wire conductor is indicated in Clause 16.12, is considered acceptable.

16.14 A bonding conductor to an electrical component need not be larger than the size of the conductors supplying the component.

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

16.16 If more than one size branch circuit overcurrent protection device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a component is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that component is sized on the basis of the overcurrent device intended for ground-fault protection of the component.

16.17 The continuity of the grounding system of the product shall not rely on the dimensional integrity of nonmetallic material.