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# ANSI/CAN/UL/ULC 2200:2020

## STANDARD FOR SAFETY

### Stationary Engine Generator Assemblies

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ANSI/UL 2200-2020



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UL Standard for Safety for Stationary Engine Generator Assemblies, ANSI/CAN/UL/ULC 2200

Third Edition, Dated September 29, 2020

### **Summary of Topics**

***This New Edition of ANSI/CAN/UL/ULC 2200 includes several substantive changes and new requirements to address current technology.***

The requirements are substantially in accordance with Proposal(s) on this subject dated September 20, 2019 and May 1, 2020.

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ANSI/UL 2200-2020

SEPTEMBER 29, 2020



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ANSI/CAN/UL/ULC 2200:2020

**Standard for Stationary Engine Generator Assemblies**

First Edition – October, 2011  
Second Edition – December, 2013

**Third Edition**

**September 29, 2020**

This ANSI/CAN/UL/ULC Safety Standard consists of the Third Edition.

The most recent designation of ANSI/UL 2200 as an American National Standard (ANSI) occurred on September 29, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on September 29, 2020.

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**ANNEX A (Normative) Grounding/bonding terms**

**ANNEX B (Informative) Markings required to be translated and suggested French and Spanish translations**

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## Preface

This is the Third Edition of ANSI/CAN/UL/ULC 2200, Standard for Safety for Stationary Engine Generator Assemblies.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO). ULC Standards is accredited by the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

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

This ANSI/CAN/UL/ULC 2200 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Annex [A](#) is identified as Normative, as such, form mandatory parts of this Standard.

Annex [B](#), identified as Informative, is 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.

This joint American National Standard and National Standard of Canada is based on, and now supersedes, the Second Edition of UL 2200.

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

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This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Stationary Engine Generator Assemblies, STP 2200.

This list represents the STP 2200 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

### STP 2200 Membership

Name	Representing	Interest Category	Region
Mathher Abbassi	NYC Dept of Buildings	AHJ	USA
Blake Allen	Marex Canada Limited	AHJ	Alberta, Canada
Phillip Brehe	Solar Turbines	Producer	USA
Donald Cook	Shelby County	AHJ	USA
Bret Dalton	GE – Gas Power and Power Services	Producer	USA
Brady Eifrid	Kohler Power Systems	Producer	USA
David Engelhart	Collier County Florida	AHJ	USA
Rick George	Intertek	Testing & Standards	USA
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International Classification for Standards (ICS): 29.160.40

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

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## INTRODUCTION

### 1 Scope

1.1 These requirements cover stationary engine generator assemblies that are intended for installation and use in ordinary locations in accordance with the following:

- a) The National Electrical Code, NFPA 70;
- b) The Canadian Electrical Code, Part I, CSA C22.1;
- c) The Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37;
- d) Natural Gas and Propane Installation Code, CSA B149.1;
- e) The Code for Digester Gas, Landfill Gas, Biogas Generation and Utilization, ANSI/CSA B149.6;
- f) The Installation Code for Oil-Burning Equipment, CSA B139;
- g) The Standard for Health Care Facilities, NFPA 99;
- h) The Code for Canadian Health Care Facilities, CSA Z8000;
- i) The Standard for Emergency, Standby Power Systems, NFPA 110; and
- j) Emergency Electrical Power Supply for Building, CSA C282.

1.2 Units that incorporate a pressure vessel shall comply with the following:

- a) ASME Boiler and Pressure Vessel Code;
- b) Boiler, Pressure Vessel, and Pressure Piping Code, CSA B51;
- c) Process Piping, ASME B31.3, and
- d) Gas-Fired Low Pressure Steam and Hot Water Boilers, ANSI Z21.13 / CSA 4.9

1.3 Hazards addressed by this Standard include electrical (energy, shock, explosion, and fire), mechanical (enclosures and moving parts), fuel related (containment and flow control for liquid and gaseous fuels including purge / dilution functions), and prime mover related hazards.

1.4 These requirements do not cover engine generator assemblies for use in hazardous (Classified) locations.

1.5 These requirements do not cover engine generator assemblies for shipboard marine applications.

### 2 Components

2.1 Except as indicated in [2.2](#), a component or auxiliary equipment used as a part of a unit covered by this Standard shall comply with the requirements for that component. A component shall comply with both the applicable United States and Canadian Standards.

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

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

2.4 Components that are incomplete in construction features or restricted in performance capabilities shall be used only under the specific conditions for which they have been evaluated.

### 3 Units of Measurement

3.1 The values given in SI (metric) units shall be normative. Any other values are for information only.

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

### 4 Glossary

4.1 In the text of this Standard, the term "unit" refers to any product covered by this Standard.

4.2 For the purpose of this Standard, the following definitions apply.

4.3 AC CONVENIENCE RECEPTACLE – A receptacle that is intended for general use.

4.4 AMBIENT AIR TEMPERATURE – The temperature determined under prescribed conditions, of the air surrounding the complete engine generator assembly, switching device or fuse. [IEC 60050-441: IEC ref 441-11-13, modified]

NOTE: For engine generator assemblies, switching devices or fuses installed inside an enclosure, it is the temperature of the air outside the enclosure.

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4.5 AUTOMATIC SAFETY SHUTOFF VALVE (ASSV) – A device consisting of a valve and operator that controls the fuel supply to the engine. The operator may be actuated by the application of fuel pressure on a flexible diaphragm, by electrical means, by mechanical means, or some other means. The valve serves as a safety device that closes upon command from the automatic engine shutdown sensor or programmable control.

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4.6 AUTOMATIC VALVE – A valve which controls the flow of fuel to the engine during normal operation, and will automatically shut off the flow of fuel to the engine in case the engine stops for any cause. Automatic valves include zero governor type regulating valves, safety shutoff valves, and combination metering safety shutoff valves. Also see [4.5](#).

Adapted from ANSI Z21.21-2015/CSA 6.5-2015 with permission of CSA Group.

4.7 AUTOMATIC SAFETY VENT VALVE (ASVV) – A valve that is automatically opens by the safety control system or by an emergency device.

4.8 BARRIER – A means of isolating that reduces the risk of access to a part that involves a risk of fire, electric shock, injury to persons, or electrical energy – high current levels. See [4.64](#) and [4.65](#).

- 4.9 BATTERY CASE/COVER – The container that directly encloses and confines the electrolyte of a battery or cell.
- 4.10 BATTERY, VALVE-REGULATED – A battery in which the venting of the products of electrolysis is controlled by a reclosing pressure-sensitive valve.
- 4.11 BATTERY, VENTED – A battery in which the products of electrolysis and evaporation escape freely to the atmosphere. These batteries have commonly been referred to as "flooded" or "wet."
- 4.12 BUS BAR – A conductor or an assembly of conductors for collecting electric currents and distributing them to outgoing feeders.
- 4.13 CAST INSULATED or CAST INSULATION – A polymeric insulating material applied to conductors, components or equipment such as transformers, windings, bus bars or coils. Cast insulated components are typically potted or fully impregnated with an epoxy resin.
- 4.14 CELL – The main components are two electrodes of dissimilar material separated from one another by a common ionically conductive electrolyte, that are intended to convert chemical energy directly into electrical energy.
- 4.15 CLASS 1 POWER LIMITED CIRCUIT – A circuit which is supplied from a source having a rated output of not more than 30 V and 1000 VA. This is often wiring between the protective overcurrent device and connected load equipment.
- 4.16 CLASS 2 CIRCUIT – A circuit which is supplied from a Class 2 transformer.
- 4.17 CLASS 2 TRANSFORMER – A step-down transformer complying with the applicable requirements in CSA C22.2 No. 66-1 / UL 5085-1 and CSA C22.2 No. 66.3 / UL 5085-3.
- 4.18 CLASS 3 CIRCUIT – In the US, a circuit which is supplied from a Class 3 Transformer.
- In Canada, Class 3 circuits are not recognized in the Canadian Electrical Code, Part I.
- 4.19 CLEARANCE – The shortest distance through air spacing between two conductive parts.
- 4.20 COMPONENT – Refers to subassemblies used in the construction of the generating assembly.
- 4.21 CONDUCTIVE PART – A part which is capable of conducting current, although it is not necessarily used for carrying current. [IEC 60050-441: IEV ref 441-11-09, modified]
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- 4.22 CONTROL CIRCUIT – A circuit used for monitoring and or control of an engine generator assembly.
- 4.23 CONTROL POWER TRANSFORMER (CPT) – A transformer utilized to supply voltage for control circuits and auxiliary devices.
- 4.24 COVER – An unhinged portion of an enclosure that covers an opening.
- 4.25 CREEPAGE DISTANCE – The shortest distance along the surface of an insulating material between two conductive parts.

- 4.26 DEDICATED PURPOSE GENERATOR OUTLET / RECEPTACLE – A receptacle used to supply power to specific purpose generator components or accessories such as block heaters, oil heaters, and battery chargers.
- 4.27 DEGREE OF PROTECTION – The extent of protection provided by an enclosure or guard to prevent access to moving parts.
- 4.28 DOOR – A hinged portion of an enclosure that covers an opening.
- 4.29 ELECTROLYTE – A semisolid, liquid, or aqueous salt solution that permits ionic conduction between positive and negative electrodes of a cell.
- 4.30 ELECTRONIC FORMAT – Any electronic media content (other than computer programs or system files) provided on commonly available physical media or internet link, which is intended to be used in either an electronic form (such as a text file or PDF) or as printed output derived from the electronic document.
- 4.31 ENCLOSURE – That portion of a unit that:
- a) Reduces the accessibility of a part that involves a risk of fire, electric shock or injury to persons; or
  - b) Reduces the risk of propagation of flame, sparks, and molten metal initiated by an electrical disturbance occurring within.
- 4.32 ENGINE – A prime mover machine that converts energy into motion that may consume fuel in the process.
- 4.33 FIELD-WIRING LEAD – Any lead to which a supply, load, or other wire is intended to be connected by an installer.
- 4.34 FIELD-WIRING TERMINAL – A terminal to which a supply, load, or other wire is intended to be connected by an installer.
- 4.35 GENERATOR ASSEMBLY – Refers to the assembly, consisting of the engine and generator/alternator.
- 4.36 GROUND – The earth.
- 4.37 GROUNDING KIT – A grounding terminal means intended to be field-connected or factory-installed, consisting of connectors (lugs) and hardware, such as bolts, studs, or screws, and suitable for connecting a conductor 14 AWG (2.08 mm<sup>2</sup>) or larger to equipment required to be grounded, which is in addition to the means for securing conduit or cable armor. It is not intended that a grounding kit consist merely of screws for direct attachment of grounding conductors.
- In Canada, a grounding kit can also be referred to as a bonding kit.
- 4.38 HEAT SINK – A piece of thermally conductive metal attached to a semiconductor or other electronic device and designed to prevent it from overheating by conducting heat away from it and radiating it to the environment.
- 4.39 IMPULSE WITHSTAND VOLTAGE – The specified peak value of impulse voltages, of prescribed form and polarity, that does not cause breakdown under specified conditions of test.

4.40 INSULATION CLASS – The classification of insulation materials for the purpose of establishing temperature limits for the use of the material.

4.41 INTERLOCK – A means relied upon to reduce the accessibility to an area that results in risk of electric shock, electrical energy – high current levels, or injury to persons until the risk has been removed, or to automatically remove the risk when access is gained.

4.42 ISOLATING MEANS (isolating switch or disconnect) – A mechanical switching device that provides, in the open position, isolating distance in the main circuit from the source of power. [IEC 60050-441: IEV ref 441-14-05, modified]

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4.43 LIMITED-ENERGY CIRCUIT – An ac or dc circuit having a voltage not exceeding 1000 volts and the energy limited to 100 volt-amperes by any of the following:

- a) Secondary winding of a transformer;
- b) One or more resistors complying with [26.10](#); or
- c) A regulating network complying with [26.11](#).

4.44 LINEAR LOAD – A load that does not rectify the current or otherwise alter the current wave shape, resulting in a load current that is proportional to the instantaneous voltage.

4.45 LIVE PART – Denotes metal or a conductive part within the unit that during intended use involves a risk of electric shock.

4.46 LOW-VOLTAGE – For this Standard, ac voltage in the range of 50 to 1,000 Vac and 1,500 Vdc (in Canada, 30 to 750 V). The applicable installation codes refer to voltages above 1,000 Vrms (750 Vrms in Canada) as “high voltage”.

4.47 LOW-VOLTAGE, LIMITED-ENERGY (LVLE) CIRCUIT – A circuit involving an alternating current voltage of not more than 30 Vrms (15 Vrms wet), 42.4 V peak (24.2 V peak wet) or a direct current voltage of not more than 42.4 V (30 V wet) and supplied by:

- a) An inherently limited Class 2 transformer or a not inherently limited Class 2 transformer and an overcurrent protective device that is:
  - 1) Not of the automatic reclosing type;
  - 2) Trip-free from the reclosing mechanism; and
  - 3) Either not readily interchangeable with a device of a different rating, or provided with a marking in accordance with [94.7](#).
- b) A combination of an isolated transformer secondary winding and one or more resistors or a regulating network complying with [26.11](#) that complies with all the performance requirements for an inherently limited Class 2 transformer or power source; or
- c) A battery that is isolated from the primary circuit or a combination of a battery, including the battery charging circuit of a unit that is isolated from the primary circuit, and one or more resistors or a regulating network complying with [26.11](#).

The DC dry voltage limit is 60 V in the US and 42.4 V in Canada, and this Standard includes the lower value for consistency.

4.48 **MECHANICAL GUARD** (or partition) – A part, barrier, or enclosure that reduces the risk of access to or separating a component from another or prevents the splashing, dripping or spraying of coolant, oil, or fuel that has the potential of causing an electrical fire, fuel fire hazard, or injury to persons.

4.49 **MEDIUM-VOLTAGE** – For this Standard, a voltage over 1,000 Vac or 1,500 Vdc (in Canada, over 750 V), up to 46 kV. The applicable installation codes refer to voltages above 1,000 Vrms (750 Vrms in Canada) as “high voltage”.

4.50 **MEDIUM-VOLTAGE COMPARTMENT** – A compartment containing one or more medium-voltage components.

4.51 **MEDIUM-VOLTAGE FUSE** – A current-limiting fuse intended for use in medium-voltage circuits, capable of interrupting all currents from the rated maximum interrupting current down to the rated minimum interrupting current (where applicable).

NOTE: See IEEE C37.40, which categorizes different types of current-limiting fuses based on their minimum interrupting current capability:

a) **BACKUP CURRENT-LIMITING FUSE** – a current-limiting fuse capable of interrupting all currents from its rated maximum interrupting current down to its rated minimum interrupting current.

b) **FULL-RANGE CURRENT-LIMITING FUSE** – a current-limiting fuse capable of interrupting, under specified conditions, all currents from its rated maximum interrupting current down to the minimum continuous current that can cause the fusible element to melt.

c) **GENERAL-PURPOSE CURRENT-LIMITING FUSE** – a current-limiting fuse capable of interrupting all currents from its rated interrupting current down to the current that causes melting of the fusible element(s) in one hour or more.

4.52 **MODULE** – A packaged functional assembly component of the generator assembly, such as engine module or generator module.

4.53 **OPERATING VOLTAGE** – The voltage across two points occurring due to normal operation of the product when controls are set in any position.

4.54 **OUTPUT RECEPTACLE** – A receptacle that is intended to carry the output power of the generator.

4.55 **OVERCURRENT** – A current exceeding the rated continuous current. Overcurrents can result from motor starting, overload, short-circuit, or ground faults.

4.56 **OVERLOAD** – Equipment operating condition exceeding normal rated current or power.

4.57 **OVERVOLTAGE CATEGORY** – Grouping of products based on typical installed location with respect to overvoltage protection and available energy.

4.58 **POLLUTION** – Any addition of contaminants, solid, liquid, or gaseous (ionized gases), and moisture that may produce a reduction of dielectric strength or surface resistivity.

4.59 **POLLUTION DEGREE** – The level of pollution present at the location on or in a product where the clearance and creepage distance measurement is made and can be controlled by design of the product. For example, enclosures can be used to achieve pollution degree 3, heaters within non-ventilated enclosures can help achieve pollution degree 2, and encapsulation can be used to achieve pollution degree 1.

4.60 PRESSURE TERMINAL CONNECTOR – A field-wiring terminal that accomplishes the connection of one or more conductors by means of pressure without the use of solder. Examples of a pressure terminal connector are the:

- a) Barrel and setscrew type;
- b) Crimp-type barrel; or
- c) Clamping plate and screw type.

4.61 PRIMARY CIRCUIT – Wiring and components that are conductively connected to a power output and or branch circuit.

4.62 RESTRICTED ACCESS AREA – A location for equipment where the following apply:

- a) Access is only gained by service personnel who have been instructed of the reasons for the restrictions applied to the location and about any precautions that must be taken; and
- b) Access is through the use of a special tool or other means of security and is controlled by the authority responsible for the rotating equipment or live component location.

4.63 RISK – Combination of the probability of occurrence of harm (i. e. physical injury or damage to health) and the severity of harm. [ISO 12100, 3.12, modified]

4.64 RISK OF ELECTRIC SHOCK – As defined in Electric Shock, Section [9](#).

4.65 RISK OF ELECTRICAL ENERGY – HIGH CURRENT LEVELS – The risk for damage to property or injury to persons, other than by electric shock, from available electrical energy is determined to exist, when between a live part and an adjacent dead metal part or between live parts of different polarity, there exists a potential of 2 V or more and either:

- a) An available continuous power level of 240 VA or more; or
- b) A reactive energy level of 20 J or more.

For example, a tool, or other metal short-circuiting a component is capable of causing a burn or a fire when enough energy is available at the component to vaporize, melt, or more than warm the metal.

4.66 RISK OF FIRE – A risk of fire exists at any component unless an investigation of the supply delivering power to that component complies with the criteria in [26.4](#) – [26.12](#).

4.67 SAFETY CIRCUIT – Any primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, injury to persons, or electrical energy – high current levels. For example, in some applications, an interlock circuit is a safety circuit.

4.68 SAFETY FUNCTION – Function of a machine whose failure can result in an immediate increase of risk(s). [ISO 12100, 3.30]

4.69 SECONDARY CIRCUIT – A circuit supplied from a secondary winding of an isolating transformer. See Section [31](#), Transformers.

4.70 SERVICE DISCONNECTING MEANS or SERVICE DISCONNECT – Isolating means that disconnects all conductors into a building or other structure from the service entrance conductors.

- 4.71 SERVICE PERSONNEL – Persons having technical training and experience required to be aware of the risks encountered when performing a task and the measures to be taken to minimize the risks to themselves and other persons. Service personnel tasks include periodic engine maintenance like changing oil and filters.
- 4.72 SKIN-TIGHT ENCLOSURE – An enclosure where required clearances are provided through the exterior to the enclosure with maintenance access to parts of the engine generator set from the outside of the enclosure with no accessibility to uninsulated live electrical components.
- 4.73 STATIONARY – A unit that is intended to be hard wired and/or permanently installed.
- 4.74 SWITCH, LOCKOUT – An indicating type switch that provides a means to disconnect all ungrounded conductors and is also provided with a positive lockout in the “off” position.
- 4.75 SWITCH, TRANSFER – A device for transferring one or more load conductor connections from one power source to another.
- 4.76 SYNCHRONIZATION – The matching of the voltage amplitude, phase angle, and frequency of the output of a generator with the amplitude, phase angle, and frequency of other generators, the electric power system or electric utility.
- 4.77 TOOL – A screwdriver, wrench, or any other special object that is a service access tool that is used to operate a screw, latch, or similar fastening means.
- 4.78 USER – Any person other than service personnel. Sometimes referred to as operator.
- 4.79 USER ACCESS AREA – An area to which, under normal operating conditions, one of the following applies:
- a) Access is gained without the use of a tool;
  - b) The means of access is deliberately provided to the user; or
  - c) The user is instructed to enter regardless of whether or not tools are required to gain access. This includes control panels, behind locked doors, and inside of access covers with guarding or barriers in place to prevent the user from accessing rotating machinery or live components.
- 4.80 UTILITY-INTERACTIVE – A generator intended for use in parallel with an electric utility or electric power system to supply common local area / micro grid system loads and sometimes deliver power to the utility.
- 4.81 WALK-IN ENCLOSURE – An enclosure that allows an operator or service person to enter inside the generator enclosure.
- 4.82 WEATHER ENCLOSURE – An enclosure for outdoor use that is integral to the engine generator and protects the engine generator assembly from the wetting of live parts in an outdoor environment while the unit is operating or is in standby.
- 4.83 WRITTEN FORMAT – A printed document, label, or molded text provided in a physical form as part of or with the product.
- 4.84 ZERO GOVERNOR REGULATOR (vacuum demand regulator) – A fuel regulating device that allows fuel flow when a partial vacuum is applied to the regulator output port. The regulator stops fuel flow when vacuum demand on the output port is discontinued.

## 5 Referenced Publications

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

5.2 Throughout this Standard, the CSA and ULC standard references apply to products intended for use in Canada, while the UL standard references apply to products intended for use in the United States. Combined references are separated by a slash (“ / ”) to denote the difference between the applicable requirements specified for use in Canada and the United States.

5.3 The following publications are referenced in this Standard:

Canada	United States
ANSI Z21.13 / CSA 4.9, Gas-Fired Low Pressure Steam and Hot Water Boilers	ANSI Z21.13 / CSA 4.9, Gas-Fired Low Pressure Steam and Hot Water Boilers
ANSI Z21.18 / CSA 6.3, Gas Appliance Pressure Regulators	ANSI Z21.18 / CSA 6.3, Gas Appliance Pressure Regulators
ANSI Z21.21 / CSA 6.5, Automatic Valves for Gas Appliances	ANSI Z21.21 / CSA 6.5, Automatic Valves for Gas Appliances
ANSI Z21.80 / CSA 6.22, Line Pressure Regulators	ANSI Z21.80 / CSA 6.22, Line Pressure Regulators
ASME B1.20.1, Pipe Threads, General Purpose (Inch)	ASME B1.20.1, Pipe Threads, General Purpose (Inch)
ASME B31.3, Process Piping	ASME B31.3, Process Piping
ASME B31.11, Slurry Transportation Piping Systems	ASME B31.11, Slurry Transportation Piping Systems
ASME B36.10M, Welded and Seamless Wrought Steel Pipe	ASME B36.10M, Welded and Seamless Wrought Steel Pipe
ASME B36.19M, Stainless Steel Pipe	ASME B36.19M, Stainless Steel Pipe
ASTM A90, Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings	ASTM A90, Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus	ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM A179 / A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes	ASTM A179 / A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
ASTM E230/E230M, Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples	ASTM E230/E230M, Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension	ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension
ASTM D471, Standard test method for rubber property – Effect of liquids, ASTM F152, Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials	UL 157, Gaskets and Seals
ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process	ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM F1120, Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications	ASTM F1120, Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM D1525, Standard Test Method for Vicat Softening Temperature of Plastics	ASTM D1525, Standard Test Method for Vicat Softening Temperature of Plastics
CAN/CGSB 12.1-M90, Tempered or Laminated Safety Glass	ANSI Z97.1, Safety glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test
CSA C22.2 No. 0.2, Insulation Coordination	UL 840, Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
CSA C22.2 No. 0.15, Adhesive Labels	UL 969, Marking and Labeling Systems
CSA C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials	UL 746C, Polymeric Materials – Use in Electrical Equipment Evaluations
CSA C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials	UL 796, Printed-Wiring Boards

Canada	United States
CSA C22.2 No. 0.19, Requirements for Service Entrance Equipment	UL 869A, Reference Standard for Service Equipment
CSA C22.2 No. 0.22, Evaluation Methods for Arc Resistance Ratings of Enclosed Electrical Equipment	IEEE C37.20.7, Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults
CSA C22.2 No. 0.8, Safety functions incorporating electronic technology	UL 1998, Software in Programmable Components
CSA C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures	UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
CSA C22.2 No. 8, Electromagnetic Interference (EMI) Filters	UL 1283, Electromagnetic Interference Filters
CSA C22.2 No. 9.0, General Requirements for Luminaires	UL 2108, Low Voltage Lighting Systems
CSA 8.3, Thermoplastic Hose And Hose Couplings For Conducting Propane And Natural Gas	UL 21, LP-Gas Hose UL 569, Pigtails and Flexible Hose Connectors for LP Gas
CGA-8.1, Elastomeric Composite Hose and Hose Couplings for Conducting Propane and Natural Gas	
CSA C22.2 No. 13, Transformers for Luminous-Tube Signs, Oil- or Gas-Burner Ignition Equipment, Cold-Cathode Interior Lighting	UL 506, Specialty Transformers
CSA C22.2 No. 14, Industrial Control Equipment	UL 508, Industrial Control Equipment
CSA C22.2 No. 18.1, Metallic Outlet Boxes	UL 514A, Metallic Outlet Boxes
CSA C22.2 No. 18.2, Nonmetallic Outlet Boxes	UL 514C, Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
CSA C22.2 No. 42.1, Cover Plates for Flush-Mounted Wiring Device	UL 514D, Cover Plates for Flush-Mounted Wiring Devices
CSA C22.2 No. 18.3, Conduit, Tubing, and Cable Fittings	UL 514B, Conduit, Tubing, and Cable Fittings
CSA C22.2 No. 26, Construction and Test of Wireways, Auxiliary Gutters, and Associated Fittings	UL 870, Wireways, Auxiliary Gutters, and Associated Fittings
CSA C22.2 No. 29, Panelboards and Enclosed Panelboards	UL 67, Panelboards
CSA C22.2 No. 31, Switchgear Assemblies	IEEE 1247, IEEE Standard for Interrupter Switches for Alternating Current Rated Above 1000 Volts IEEE C37.20.2, IEEE Standard for Metal-Clad Switchgear IEEE C37.20.3, Metal-Enclosed Interrupter Switchgear (1 kV – 38 kV) IEEE C37.20.4, Indoor AC Switches (1 kV to 38 kV) for Use in Metal-Enclosed Switchgear NEMA C37.54, For Indoor Alternating Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear – Conformance Test Procedures NEMA C37.57, For Switchgear – Metal-Enclosed Interrupter Switchgear Assemblies – Conformance Testing NEMA C37.58, For Switchgear – Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear – Conformance Test Procedures NEMA CC1, Electric Power Connection for Substations
CSA C22.2 No. 42.1, Nonmetallic Outlet Boxes	UL 514C, Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
CSA C22.2 No. 46, Electric Air Heaters	UL 499, Electric Heating Appliances
CSA C22.2 No. 47, Air-Cooled Transformers (Dry Type)	UL 1561, Dry-Type General Purpose and Power Transformers
CSA B51, Boiler, pressure vessel, and pressure piping code	ASME B31.3, Process Piping
CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code	ASME Boiler and pressure vessel Code VIII Rules for Construction of Pressure Vessels, Division 1
CSA C22.2 No. 65, Wire Connectors	UL 486A-486B, Wire Connectors
CSA C22.2 No. 65, Wire Connectors	UL 486E, Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

Canada	United States
CSA C22.2 No. 66.1, Low Voltage Transformers – Part 1: General Requirements	UL 5085-1, Low Voltage Transformers – Part 1: General Requirements
CSA C22.2 No. 66.2, Low Voltage Transformers – Part 2: General Purpose Transformers	UL 5085-2, Low Voltage Transformers – Part 2: General Purpose Transformers
CSA C22.2 No. 66.3, Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers	UL 5085-3, Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables	UL 83, Thermoplastic-Insulated Wires and Cables
CSA C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-Environmental Considerations	UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations
CSA C22.2 No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations	UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
CSA C22.2 No. 107.1, Power Conversion Equipment	UL 1012, Power Units Other Than Class 2
CSA C22.2 No. 107.1, Power Conversion Equipment	UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
CSA C22.2 No. 107.2, Battery Chargers	UL 1236, Battery Chargers for Charging Engine-Starter Batteries
CSA C22.2 No. 107.3, Uninterruptible Power Systems	UL 1778, Uninterruptible Power Systems
CSA C22.2 No. 100, Motors and Generators	UL 1004-4, Electric Generators
CSA C22.2 No. 111, General-Use Snap Switches	UL 20, General-Use Snap Switches
CSA C22.2 No. 139, Electrically Operated Valves	UL 429, Electrically Operated Valves UL 428A, Electrically Operated Valves for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations Up to 85 Percent (E0 – E85) UL 428B, Electrically Operated Valves for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil
CSA C22.2 No. 141, Emergency Lighting Equipment	UL 924, Emergency Lighting and Power Equipment
CSA C22.2 No. 144, Ground Fault Circuit Interrupters	UL 943C, Outline for Special Purpose Ground-Fault Circuit-Interrupters
CSA C22.2 No. 144.1, Ground-Fault Circuit-Interrupters	UL 943, Ground-Fault Circuit-Interrupters
CSA B149.1, Natural Gas and Propane Installation Code	UL 181, Factory-Made Air Ducts and Air Connectors
CSA B149.6, Code for digester gas, landfill gas, and biogas generation and utilization	ANSI/CSA B149.6, Code for digester gas, landfill gas, and biogas generation and utilization
CSA C22.2 No. 153, Electrical Quick-Connect Terminals	UL 310, Electrical Quick-Connect Terminals
CSA C22.2 No. 165, Electric Boilers	UL 834, Heating, Water Supply, and Power Boilers – Electric
CSA C22.2 No. 178.1, Transfer Switch Equipment	UL 1008, Transfer Switch Equipment
CSA C22.2 No. 190, Capacitors for Power Factor Correction	UL 810, Capacitors
CSA C22.2 No. 197, PVC Insulating Tape	UL 510, Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
CSA C22.2 No. 198.1, Extruded Insulating Tubing	UL 224, Extruded Insulating Tubing
CSA C22.2 No. 223, Power Supplies with Extra-Low-Voltage Class 2 Outputs	UL 1310, Class 2 Power Units
CSA C22.2 No. 236, Heating and Cooling Equipment	UL 1995, Heating and Cooling Equipment
CSA C22.2 No. 250.0, Luminaires	UL 1598, Luminaires
CSA C22.2 No. 250.0, Luminaires	UL 2108, Low Voltage Lighting Systems
CSA C22.2 No. 253, Medium-Voltage AC Contactors, Controllers, and Control Centres	UL 347, Medium-Voltage AC Contactors, Controllers, and Control Centers
CSA C22.2 No. 268, Power circuit breakers up to 1000 Vac/1500 Vdc	UL 1066, Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures
CSA C282, Emergency Electrical Power Supply for Buildings	NFPA 110, Emergency and Standby Power Systems

Canada	United States
CSA C22.2 No. 295, Neutral Grounding Devices	IEEE C57.32, Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
CSA C22.2 No. 301, Industrial Electrical Machinery	NFPA 79, Electrical Standard for Industrial Machinery
CSA E60384-14, Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains	UL 60384-14, Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains
CSA C22.2 No. 60529, Degrees of Protection Provided by Enclosures (IP Code)	IEC 60529, Degrees of Protection Provided by Enclosures (IP Code)
CSA-E60730-1, Automatic Electrical controls – Part 1: General Requirements	UL 60730-1, Automatic Electrical Controls – Part 1: General Requirements
CSA C22.2 No. 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements	UL 1989, Standby Batteries
CSA C22.2 No. 61010-2-030, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Testing and Measuring Circuits	UL 61010-2-030, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Testing and Measuring Circuits
CSA C61869-1, Instrument Transformers – Part 1: General Requirements and CSA C61869-5, Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers, which is an adoption, with Canadian deviations, of the identically titled IEC (International Electrotechnical Commission) Standard 61869-5 (first edition, 2011-07)	IEEE C57.13, Requirements for Instrument Transformers, and IEEE C57.13.5, Performance and Test Requirements for Instrument Transformers of a Nominal System Voltage of 115 kV and Above
CSA C61869-1, Instrument Transformers – Part 1: General Requirements, CSA C61869-2, Instrument Transformers – Part 2: Additional Requirements for Current Transformers, CSA C61869-3, Instrument Transformers – Part 3: Additional Requirements for Inductive Voltage Transformers	IEEE C57.13, Requirements for Instrument Transformers, and IEEE C57.13.2, Conformance Test Procedure for Instrument Transformers
	UL 795, Commercial-Industrial Gas Heating Equipment
CSA Component Acceptance Service Notice No. 5, Component Acceptance Service for Optocouplers and Related Devices	UL 1577, Optical Isolators
IEC 60417 Database, Graphical Symbols for Use on Equipment	IEC 60417 Database, Graphical Symbols for Use on Equipment
IEC 60695-2-13, Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials	IEC 60695-2-13, Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials
IEC 61508, Functional safety of electrical/electronic/programmable electronic safety-related systems	IEC 61508, Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61508-2, Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems	IEC 61508-2, Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61508-3, Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements	IEC 61508-3, Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements
IEC 62061, Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems	IEC 62061, Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems
IEEE 4, High-Voltage Testing Techniques	IEEE 4, High-Voltage Testing Techniques
	IEEE C37.09, Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
	IEEE C37.40, Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

Canada	United States
ISO 10380, Pipework – Corrugated metal hoses and hose assemblies	ISO 10380, Pipework – Corrugated metal hoses and hose assemblies
ISO 13849-1, Safety Of Machinery – Safety-Related Parts Of Control Systems – Part 1: General Principles For Design	ISO 13849-1, Safety Of Machinery – Safety-Related Parts Of Control Systems – Part 1: General Principles For Design
ISO 7000, Graphical symbols for use on equipment – Registered symbols	ISO 7000, Graphical symbols for use on equipment – Registered symbols
ISO 7010, Graphical symbols – Safety colours and safety signs – Registered safety signs	ISO 7010, Graphical symbols – Safety colours and safety signs – Registered safety signs
ISO 12100, Safety of machinery – General principles for design – Risk assessment and risk reduction	ISO 12100, Safety of machinery – General principles for design – Risk assessment and risk reduction
ISO 19372, Microturbines applications – Safety	ISO 19372, Microturbines applications – Safety
National Building Code of Canada – Emergency Lighting	NFPA 101, Life Safety Code
NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines	NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54/ANSI Z223.1, National Fuel Gas Code	NFPA 54/ANSI Z223.1, National Fuel Gas Code
	UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
ULC-C252, Guide for the Investigation of Gas Pressure Regulators	UL 252, Compressed Gas Regulators
	UL 723, Test for Surface Burning Characteristics of Building Materials
	UL 746A, Polymeric Materials – Short Term Property Evaluations
	UL 746B, Polymeric Materials – Long Term Property Evaluations
	UL 810A, Electrochemical Capacitors
	UL 991, Tests for Safety-Related Controls Employing Solid-State Devices
ANSI/AGA NGV3.1/CGA NGV 12.3, Fuel System Components for Natural Gas Powered Vehicles	UL 1337, LP-Gas, Natural Gas, and Manufactured Gas Devices for Engine Fuel Systems
	UL 1439, Tests for Sharpness of Edges on Equipment
	UL 1446, Systems of Insulating Materials – General
	UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
ANSI/CAN/UL/ULC 6200, Controllers for Use in Power Production	ANSI/CAN/UL/ULC 6200, Controllers for Use in Power Production
ANSI/CAN/UL 9540, Energy Storage Systems and Equipment	ANSI/CAN/UL 9540, Energy Storage Systems and Equipment
ANSI/CAN/UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	ANSI/CAN/UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
ULC-S111, Standard Method of Fire Tests for Air Filter Units	UL 900, Air Filter Units
ULC-S601, Shop Fabricated Steel Aboveground Tanks For Flammable And Combustible Liquids	UL 142A, Special Purpose Aboveground Tanks for Specific Flammable or Combustible Liquids
ULC/ORD-C536, Flexible Metallic Hose	UL 536, Flexible Metallic Hose
ULC/ORD-C558, Guide for the Investigation of Internal Combustion Engine-Powered Industrial Trucks	UL 558, Industrial Trucks, Internal Combustion Engine-Powered
ULC-S629, 650 Degrees C Factory-Built Chimneys	UL 103, Factory-Built Chimneys for Residential Type and Building Heating Appliances
ULC/ORD-C959, 540 Degrees C and 760 Degrees C Industrial Chimneys	UL 2561, 1400 Degree Fahrenheit Factory-Built Chimneys

## CONSTRUCTION

### 6 Materials

6.1 The material of a part, such as an enclosure, a frame, a guard, or similar part, the breakage of which results in a risk of injury to persons, shall have such properties as to meet the demand of expected use conditions.

6.2 The requirement in [6.1](#) applies to those portions of a part adjacent to moving parts that involve a risk of injury to persons.

6.3 A part as specified in [6.1](#) shall withstand the impact test described in [80.3](#), without being affected to the extent that:

- a) The performance is adversely affected so as to result in a risk of injury; or
- b) Parts capable of causing injury to persons are exposed to unintentional contact.

*Exception: A component such as a pilot lamp, lens, or control knob is not required to be subjected to the impact test.*

### 7 Frame and Enclosure

#### 7.1 General

7.1.1 A unit shall be provided with one or more enclosures that house all live parts. The enclosure shall protect the various parts of the unit against mechanical damage from forces external to the unit. The parts of the enclosure that are required to be in place to comply with the requirements for risk of fire, electric shock, injury to persons, and electrical energy – high current levels – shall comply with the applicable enclosure requirements specified in this Standard. Terminals that do not present a risk of electric shock but do present a risk of electrical high energy levels such as battery terminals, starter relay/contactors terminals, and terminals on engine-mounted battery-charging alternators within the engine compartment shall be insulated and secured in a manner where the terminal is not able to be removed except for servicing of the part and protected from contact by:

- a) An insulator that complies with the requirements in Section [38](#), Insulating Materials; or
- b) An insulating boot/barrier made from polyvinyl-chloride, neoprene, silicone rubber or a rubber compound or material.

*Exception: Live parts, including terminals, which do not present a risk of electric shock or a risk of electrical energy – high current levels, are not required to be enclosed.*

7.1.2 The frame or chassis of a unit shall not be used to carry current during intended operation (see [20.11](#)).

*Exception: Engines and their components may be used to carry current for normal engine operation but the resulting voltage from the current passing through an engine part shall not exceed the voltage levels in [Table 9.1](#).*

7.1.3 A part, such as a dial, display face, or nameplate, that serves as a functional part of the enclosure shall comply with the enclosure requirements.

7.1.4 When an electrical instrument, such as a meter, forms part of the enclosure, the face or the back of the instrument housing, or both together, shall comply with the requirements for an enclosure.

*Exception: This requirement does not apply to a meter complying with the requirements in CSA C22.2 No. 61010-2-030 / UL 61010-2-030.*

## 7.2 Enclosures and guards

7.2.1 The generator shall be evaluated for risk of injury to persons from electrical hazards, mechanical hazards and burn hazards. This shall include consideration of the results of breakdown or malfunction of any component; not more than one component at a time, unless one event contributes to another. When the investigation shows that breakdown, leak, or malfunction of a particular component can result in a hazard to service personnel or user, that component shall be investigated for reliability. Guards and protective devices shall be suitable for the intended use and hazards involved and shall not be easily defeated. Whether a mechanical guard, a release, an interlock, or similar device is required and whether such a device is applicable shall be determined from an investigation of the complete unit, its operating characteristics, and the risk of injury to persons resulting from a cause other than gross negligence.

7.2.2 The rotor of a motor, a pulley, a fan blade, a belt, a gear, or other moving part that is capable of causing injury to persons shall be enclosed or provided with other guarding means to reduce the risk of unintentional contact with the hazard.

7.2.3 The degree of protection required by [7.2.2](#) depends upon the general construction and intended use of a guarding means. Protection for service personnel shall be provided such that the risk of unintentional contact with hazardous moving parts is greatly reduced during servicing operations involving other parts of the equipment.

*Exception: This requirement does not apply to major repairs that expose trained and qualified repair personnel to hazards that are not able to be addressed by common barriers because of the nature and location of the repair. These repairs often include but are not limited to significant generator disassembly or removal of guards and will require specific specialized documented repair procedures as required by [96.4\(s\)](#) to provide guidance on how to perform the major repair work and to alert the repair persons to hazard exposure while performing the specialized major repair work.*

7.2.4 A moving part that involves a risk of injury to persons shall comply with the requirements specified in Section [8](#), Protection of Users – Accessibility of Uninsulated Live Parts and Moving Parts – and User Servicing, taking into account:

- a) The degree of exposure required to perform its intended function;
- b) The sharpness of the moving part;
- c) The risk of unintentional contact with the moving part;
- d) The speed of the moving part; and
- e) The risk that a part of the body is endangered or the risk that clothing is capable of being entangled, resulting in a risk of injury to persons.

These factors are to be considered with respect to both intended operation and foreseeable misuse.

7.2.5 Mechanical guarding shall be used where necessary on hot surfaces, radiant heat sources, fluid system piping unions, flanges, and fittings in the event of a leak to reduce or contain splashing, dripping or spraying of coolant, oil or fuel to reduce the potential risk of causing an electrical fire, fuel fire hazard or injury to persons.

7.2.6 Enclosures for medium voltage generators shall be metallic and built to the requirements of UL 50 / CSA C22.2 No. 94.1. External parts of the enclosure may be of insulating material, provided that medium-voltage parts are completely enclosed by grounded metallic partitions. These metallic partitions shall meet the thickness requirements of UL 50 / CSA C22.2 No. 94.1.

*Exception: These requirements do not apply to inspection windows complying with the requirements for Inspection Windows, 5.102.205, of UL 347 / CSA C22.2 No. 253.*

7.2.7 Generators containing both low and medium voltage components and circuit wiring shall be provided with an enclosure surrounding all medium voltage parts in accordance with [7.2.6](#). Low voltage parts may be located in a separate enclosure that complies with the enclosure requirements of this standard other than [7.2.6](#).

### 7.3 Access doors and covers

7.3.1 A door shall be provided to allow access to a fuse or other overload-protective device, if the functioning requires renewal or resetting, or where it is required to open the door in connection with intended operation of the unit. A means shall be provided to hold the door closed. When the door encloses medium voltage components or wiring, it shall also comply with [7.3.4](#) and [7.3.5](#).

*Exception No. 1: A door is not required when the only overload-protective device enclosed is:*

- a) Connected in a control circuit, provided the protective device and the circuit loads are within the same enclosure;
- b) Rated 2 A or less for loads not exceeding 100 VA;
- c) An extractor fuse having an integral enclosure; or
- d) Connected in a low-voltage, limited-energy circuit.

*Exception No. 2: A door is not required for an enclosure for low voltage equipment that:*

- a) Contains no user-serviceable or -operable parts; and
- b) Is marked in accordance with [94.6](#).

7.3.2 Doors and covers that provide user or service access, including the function specified in [7.3.1](#), shall be constructed such that they open to no less than 90 degrees from the closed position.

*Exception: A wind strap, chain, or similar attachment that may be detached without the use of tools to open the door or cover to no less than 90 degrees meets the intent of this requirement.*

7.3.3 A door or cover that provides access to a fuse or other overload-protective device shall be tight-fitting or self-latching.

7.3.4 Doors giving access to medium-voltage compartments shall be provided with one of the following interlock systems:

- a) An interlock that is solely mechanical, such that the door cannot be opened unless all medium voltage components or wiring in the compartment are de-energized. The interlock shall also prevent energizing any medium voltage components or wiring in the compartment until the door is closed. Electrical or electro-mechanical interlocks may be provided in addition to the required mechanical interlock, but shall not replace the requirement for a solely mechanical interlock. (The use of a captive key interlocking system is one method to provide mechanical interlocking.); or

b) An electromechanical interlock system that combines electrical and mechanical interlock protection that complies with all the following:

1) The interlock system shall prevent an enclosure door from being opened unless all medium voltage components or wiring in the compartment are de-energized. The interlock shall also prevent energizing any medium voltage components or wiring in the compartment until the door is closed.

NOTE: UL/ULC 6200 includes requirements for disabling generator starting which is one means to energize a medium voltage circuit.

2) The interlock system shall have at least two different protection means:

- i) With different actuation methodologies; and
- ii) Requires use of a tool to disable the protection.

3) The interlock system shall comply with the functional safety requirements in [Table 7.1](#).

**Table 7.1  
Functional safety standards**

Interlocks using electronic devices	Standard for Safety for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. Critical components evaluated using the Computational Investigation method shall have predicted failure rates equivalent or better than IEC 61508 SIL 2 or ISO 13849-1 PL d.
Interlocks using firmware/software	Standard for Software in programmable components and or equipment, UL 1998. UL 1998 shall be used in conjunction with Functional Safety standards, such as UL 991, to also evaluate discrete component hardware and non-programmable IC's.
Alternate standards may be used in place of UL 1998 and UL 991 for evaluating the unit's functional safety. If other standards are used, the environmental stress testing as described in UL 991 shall be applied in addition to the requirements of the other standards. If tests in the other standards are similar to those prescribed in UL 991, the more severe criteria of both standards shall be applied.	
Automatic Electrical Controls – Part 1: General requirements, UL 60730-1. A unit shall comply with Control Class B as a minimum.	
<ul style="list-style-type: none"> <li>• Functional Safety of Electrical/Electronic/Programmable Electronic Safety Related Systems, IEC 61508. A unit shall comply with a minimum of SIL 2.</li> <li>• Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems, IEC 62061. A unit evaluated to this standard shall comply with a minimum of SIL CL 2.</li> <li>• Safety of Machinery – Safety-Related Parts of Control Systems – Part 1: General Principles for Design, ISO 13849-1. A unit shall comply with a minimum of PL d.</li> </ul>	

7.3.5 Covers giving access to medium-voltage compartments shall comply with all the following conditions:

- a) The cover shall be bolted on all sides with a minimum of two bolts per side;
- b) No bolts are operable by hand, without the use of a tool;
- c) All bolts are captive fasteners;
- d) The cover does not provide access to fuses; and
- e) The cover shall be marked in accordance with [95.1](#) for the unit's operating voltage.

## 7.4 Cast metal enclosures

7.4.1 The thickness of cast metal for an enclosure shall be as specified in [Table 7.2](#).

*Exception: Cast metal of a lesser thickness is not prohibited when upon investigation (consideration being given to the shape, size, and function of the enclosure), it is found to be mechanically equivalent for the intended use.*

**Table 7.2**  
**Thickness of cast-metal enclosures**

Use, or dimension of area involved	Minimum thickness, mm (inch)			
	Die-cast metal		Cast metal of other than the die-cast type	
Area of 154.8 cm <sup>2</sup> (24 square inches) or less and having no dimension greater than 152 mm (6 inches)	1.6	(1/16) <sup>a</sup>	3.2	(1/8)
Area greater than 154.8 cm <sup>2</sup> (24 square inches) or having any dimension greater than 152 mm (6 inches)	2.4	(3/32)	3.2	(1/8)
At a threaded conduit hole	6.4	(1/4)	6.4	(1/4)
At an unthreaded conduit hole	3.2	(1/8)	3.2	(1/8)

<sup>a</sup> The area limitation for metal 1.6 mm (1/16 inch) thick is obtained by the provision of reinforcing ribs subdividing a larger area.

## 7.5 Sheet metal enclosures

7.5.1 Sheet metal enclosures shall comply with [7.5.2](#) or the requirements in CSA C22.2 No. 94.1 / UL 50.

7.5.2 For enclosures of low voltage circuits, the thickness of a sheet-metal enclosure shall not be less than that specified in [Table 7.3](#) and [Table 7.4](#). Uncoated steel shall not be less than 0.81 mm (0.032 inch) thick, zinc-coated steel shall not be less than 0.86 mm (0.034 inch) thick, and nonferrous metal shall not be less than 1.14 mm (0.045 inch) thick for surfaces of an enclosure at which a wiring system is to be connected.

*Exception No. 1: The thickness of a sheet metal enclosure is not prohibited from being less than specified in [Table 7.3](#) and [Table 7.4](#) when investigated and determined to be mechanically equivalent per the applicable deflection requirements and tests in UL 50.*

*Exception No. 2: For enclosures for low voltage circuits, the thickness of an enclosure may be two gauge sizes less than indicated in [Table 7.3](#) and [Table 7.4](#), when uninsulated live parts are located at least 64 mm (2-1/2 inches) from the surface, and 4 gauge sizes less when the uninsulated live parts are located at least 128 mm (5 inches) from the surface. The thickness shall be not less than No. 24 MSG or GSG (steel), or 18 AWG (aluminum, copper, or brass), unless a lesser thickness is acceptable in accordance with [Table 7.3](#) and [Table 7.4](#). An example of 2 gauge sizes less is No. 18 MSG instead of No. 16 MSG; an example of 4 gauge sizes less is No. 20 MSG instead of No. 16 MSG.*

**Table 7.3  
Thickness of carbon steel or stainless steel enclosures**

Without supporting frame <sup>a</sup>		With supporting frame or equivalent reinforcing <sup>a</sup>				Minimum thickness, mm (inch)	
Maximum width <sup>b</sup>		Maximum length <sup>c</sup>		Maximum width <sup>b</sup>		Maximum length	
cm	(Inches)	cm	(Inches)	cm	(Inches)	Uncoated	Metal Coated
10.2	(4.0)	Not limited		15.9	(6.25)	Not limited	
12.1	(4.75)	14.6	(5.75)	17.1	(6.75)	21.0	(8.25)
						0.51 <sup>d</sup>	(0.020)
						0.58 <sup>d</sup>	(0.023)
15.2	(6.0)	Not limited		24.1	(9.5)	Not limited	
17.8	(7.0)	22.2	(8.75)	25.4	(10.0)	31.8	(12.5)
						0.66 <sup>d</sup>	(0.026)
						0.74 <sup>d</sup>	(0.029)
20.3	(8.0)	Not limited		30.5	(12.0)	Not limited	
22.9	(9.0)	29.2	(11.5)	33.0	(13.0)	40.6	(16.0)
						0.81	(0.032)
						0.86	(0.034)
31.8	(12.5)	Not limited		49.5	(19.5)	Not limited	
35.6	(14.0)	45.7	(18.0)	53.3	(21.0)	63.5	(25.0)
						1.07	(0.042)
						1.14	(0.045)
45.7	(18.0)	Not limited		68.6	(27.0)	Not limited	
50.8	(20.0)	63.5	(25.0)	73.7	(29.0)	91.4	(36.0)
						1.35	(0.053)
						1.42	(0.056)
55.9	(22.0)	Not limited		83.8	(33.0)	Not limited	
63.5	(25.0)	78.7	(31.0)	88.9	(35.0)	109.2	(43.0)
						1.52	(0.060)
						1.60	(0.063)
63.5	(25.0)	Not limited		99.1	(39.0)	Not limited	
73.7	(29.0)	91.4	(36.0)	104.1	(41.0)	129.5	(51.0)
						1.70	(0.067)
						1.78	(0.070)
83.8	(33.0)	Not limited		129.5	(51.0)	Not limited	
96.5	(38.0)	119.4	(47.0)	137.2	(54.0)	167.6	(66.0)
						2.03	(0.080)
						2.13	(0.084)
106.7	(42.0)	Not limited		162.6	(64.0)	Not limited	
119.4	(47.0)	149.9	(59.0)	172.7	(68.0)	213.4	(84.0)
						2.36	(0.093)
						2.46	(0.097)
132.1	(52.0)	Not limited		203.2	(80.0)	Not limited	
152.4	(60.0)	188.0	(74.0)	213.4	(84.0)	261.6	(103.0)
						2.74	(0.108)
						2.82	(0.111)
160.0	(63.0)	Not limited		246.4	(97.0)	Not limited	
185.4	(73.0)	228.6	(90.0)	261.6	(103.0)	322.6	(127.0)
						3.12	(0.123)
						3.20	(0.126)

<sup>a</sup> See 7.5.4 and 7.5.5.

<sup>b</sup> The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure are not prohibited from having supports in common and being made of a single sheet.

<sup>c</sup> "Not limited" applies only where the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

<sup>d</sup> Sheet steel for an enclosure intended for outdoor use shall not be less than 0.86 mm (0.034 inch) thick when metal coated and not less than 0.81 mm (0.032 inch) thick when uncoated.

**Table 7.4  
Thickness of aluminum, copper, or brass enclosures**

Without supporting frame <sup>a</sup>		With supporting frame or equivalent reinforcing <sup>a</sup>				Minimum thickness	
Maximum width <sup>b</sup>		Maximum length <sup>c</sup>		Maximum width <sup>b</sup>		Maximum length	
cm	(Inches)	cm	(Inches)	cm	(Inches)	mm	(Inches)
7.6	(3.0)	Not limited		17.8	(7.0)	Not limited	
8.9	(3.5)	10.2	(4.0)	21.6	(8.5)	24.1	(9.5)
						0.58 <sup>d</sup>	(0.023)

Table 7.4 Continued on Next Page

Table 7.4 Continued

Without supporting frame <sup>a</sup>		With supporting frame or equivalent reinforcing <sup>a</sup>		Minimum thickness
Maximum width <sup>b</sup>	Maximum length <sup>c</sup>	Maximum width <sup>b</sup>	Maximum length	
cm (Inches)	cm (Inches)	cm (Inches)	cm (Inches)	mm (Inches)
10.2 (4.0)	Not limited	25.4 (10.0)	Not limited	0.74 (0.029)
12.7 (5.0)	15.2 (6.0)	26.7 (10.5)	34.3 (13.5)	
15.2 (6.0)	Not limited	35.6 (14.0)	Not limited	0.91 (0.036)
16.5 (6.5)	20.3 (8.0)	38.1 (15.0)	45.7 (18.0)	
20.3 (8.0)	Not limited	48.3 (19.0)	Not limited	1.14 (0.045)
24.1 (9.5)	29.2 (11.5)	53.3 (21.0)	63.5 (25.0)	
30.5 (12.0)	Not limited	71.1 (28.0)	Not limited	1.47 (0.058)
35.6 (14.0)	40.6 (16.0)	76.2 (30.0)	94.0 (37.0)	
45.7 (18.0)	Not limited	106.7 (42.0)	Not limited	1.91 (0.075)
50.8 (20.0)	63.5 (25.0)	114.3 (45.0)	139.7 (55.0)	
63.5 (25.0)	Not limited	152.4 (60.0)	Not limited	2.41 (0.095)
73.7 (29.0)	91.4 (36.0)	162.6 (64.0)	198.1 (78.0)	
94.0 (37.0)	Not limited	221.0 (87.0)	Not limited	3.10 (0.122)
106.7 (42.0)	134.6 (53.0)	236.2 (93.0)	289.6 (114.0)	
132.1 (52.0)	Not limited	312.4 (123.0)	Not limited	3.89 (0.153)
152.4 (60.0)	188.0 (74.0)	330.2 (130.0)	406.4 (160.0)	

<sup>a</sup> See [7.5.4](#) and [7.5.5](#)

<sup>b</sup> The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure are not prohibited from having supports in common and being made of a single sheet.

<sup>c</sup> "Not limited" applies only when the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

<sup>d</sup> Sheet copper, brass, or aluminum for an enclosure intended for outdoor use shall not be less than 0.74 mm (0.029 inch) thick.

7.5.3 It should be noted that [Table 7.3](#) and [Table 7.4](#) are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

7.5.4 With reference to [Table 7.3](#) and [Table 7.4](#), a supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has the same outside dimensions as the enclosure surface and that has the torsional rigidity to resist the bending moments that are applied via the enclosure surface. An example of a construction that has equivalent reinforcement is one that produces a structure that is as rigid as one built with a frame of angles or channels as demonstrated by compliance with the applicable deflection requirements and tests in UL 50. In addition to the requirements of UL 50, as a result of the UL 50 deflection testing the unit shall not have:

- a) Permanent distortion to the extent that spacings are reduced below the values specified in [Table 25.1](#);
- b) Transient distortion that produces contact of the enclosure with uninsulated live parts other than those connected in a low-voltage circuit; and
- c) Development of openings that expose uninsulated live parts that involve a risk of electric shock or electrical energy – high current levels. Any openings resulting from the tests are to be judged under the requirements in Section 8, Protection of Users – Accessibility of Uninsulated Live Parts and Moving Parts – and User Servicing.

Wet location units shall apply the Deflection Tests of UL 50 / CSA C22.2 No. 94.1 as preconditioning for the Rain Test in Section [103](#), Performance.

7.5.5 With reference to [7.5.4](#) and [Table 7.3](#) and [Table 7.4](#), a construction does not have a supporting frame when it is:

- a) A single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed;
- c) An enclosure formed or fabricated from sheet metal; or
- d) An enclosure surface loosely attached to a frame – for example, by spring clips.

## 7.6 Nonmetallic enclosures

7.6.1 A polymeric enclosure or polymeric part of an enclosure for low voltage components, circuits, and wiring shall comply with the requirements for stationary equipment in CSA C22.2 No. 0.17 / UL 746C.

7.6.2 A component, piece, or nonmetallic part that forms part of an enclosure housing only low voltage components, circuits, and wiring need not comply with the requirement in [7.6.1](#) under any one of the following conditions:

- a) The part covers an opening that has no dimension greater than 25.4 mm (1 inch) and the component is made of a material classed as V-0, V-1, V-2, or HB;
- b) The part is made of a material Classed V-0, V-1, V-2, or HB and covers an opening which does not give access to the user, when the part is removed, to live parts involving a risk of fire, electric shock, electric energy-high current levels, or to moving parts;
- c) The part covers an opening that has no dimension greater than 101.6 mm (4 inches) and the part is made of a material classed as V-0, V-1, V-2, or HB, and there is no source of a risk of fire (see [4.66](#)) closer than 101.6 mm (4 inches) from the surface of the enclosure; or
- d) The part is made of a material classed V-0, V-1, V-2, or HB and there is a barrier or a device that forms a barrier made of a material classed V-0 between the part and a source of a risk of fire.

The flammability classification shall be in accordance with UL 94.

*Exception: A part of a component need not be classed V-0, V-1, V-2, or HB when it complies with the same flammability class applicable to the component.*

7.6.3 An external polymeric material enclosure having in any single unbroken section, a projected surface area greater than 0.93 m<sup>2</sup> (10 square feet), or a single linear dimension greater than 1.83 m (6 feet) shall have a flame-spread rating of 200 or less when tested in accordance with UL 723 or IEC 60695-2-13.

7.6.4 A material with a flame-spread rating higher than specified in [7.6.3](#) is not prohibited from being used as the exterior finish or covering on any portion of the enclosure when the flame-spread rating of the combination of the base material and finish or covering complies with [7.6.3](#).

7.6.5 A conductive coating applied to a nonmetallic surface (such as the inside surface of a cover or an enclosure) shall comply with the applicable requirements in CSA C22.2 No. 0.17 / UL 746C.

*Exception: When flaking or peeling of the coating does not result in a risk of fire or electric shock as a result of a reduction of spacings or the bridging of live parts, then the coating need not comply with CSA C22.2 No. 0.17 / UL 746C.*

7.6.6 Engine and exhaust areas that are part of an enclosure that incorporate thermal insulation shall comply with the thermal insulation 20-mm (3/4-inch) flame test of [103.4](#).

7.6.7 Intake plenum areas that are part of an enclosure that incorporate sound insulation lining shall comply with the thermal insulation 20-mm (3/4-inch) flame test of [103.4](#) or have a flame spread index of 0 – 25 when tested in accordance with UL 723 / IEC 60695-2-13.

7.6.8 For internal areas of the engine generator walk-in enclosure where users or service persons are intended to enter the space to operate or service it, polymeric materials such as polymeric enclosures, polymeric access barriers, walls of an enclosure, or insulation on the walls of an engine generator shall be rated as follows. Any single unbroken section greater than 0.93 m<sup>2</sup> (10 square feet) or a single linear dimension greater than 1.83 m (6 feet) shall have a maximum flame spread index and smoke developed index as shown in [Table 7.5](#) as tested in accordance with the UL 723.

*Exception: This requirement does not apply to the following:*

- a) Wire and cables; and
- b) Materials less than 0.9 mm (0.036 inch) thick directly applied to walls, floors, or ceiling surfaces.

**Table 7.5**  
**Sound and thermal enclosure insulation index**

Location within enclosure	Flame spread index	Smoke developed index
Walk-in area	0 – 25	0 – 50
Intake Plenum area	0 – 25	0 – 50
Void area	76 – 200	0 – 450

## 7.7 Viewing panes

7.7.1 A viewing pane covering an opening in a low voltage compartment shall be secured in place so that it is not readily displaced in service and provides mechanical protection for the enclosed parts.

7.7.2 Glass for an opening in a low voltage compartment shall comply with the following dimensions:

- a) Glass for an opening not more than 102 mm (4 inches) in any dimension shall not be less than 1.6 mm (1/16 inch) thick;
- b) Glass for an opening not more than 929 cm<sup>2</sup> (144 square inches) in area and having no dimension greater than 305 mm (12 inches) shall not be less than 3.2 mm (1/8 inch) thick; and
- c) Glass used to cover an area larger than noted in (b) shall not be less than 3.2 mm (1/8) inch thick and shall:
  - 1) Be of a non-shattering or tempered type, wire reinforced that, when broken, complies with CAN/CGSB 12.1-M90 / ANSI Z97.1; or
  - 2) Be subjected to the test described in [80.2](#).

7.7.3 Viewing panes covering an opening in a medium voltage compartment shall: