UL 2200

STANDARD FOR SAFETY

Stationary Engine Generator Assemblies

UL Standard for Safety for Stationary Engine Generator Assemblies, UL 2200

Second Edition, Dated June 1, 2012

Summary of Topics

The revision pages dated July 29, 2015 were issued to incorporate the following new and revised requirements:

- ***Revision to Paragraph 41.1.3.3 to Add Higher Pressure Flexible Fuel Tubing and Hose Types for Gasoline or Diesel Fuel***

The new/revised requirements are substantially in accordance with Proposal(s) on this subject dated April 10, 2015 and June 12, 2015.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

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UL 2200

Standard for Stationary Engine Generator Assemblies

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Second Edition

June 1, 2012

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through July 29, 2015.

The most recent designation of ANSI/UL 2200 as an American National Standard (ANSI) occurred on July 29, 2015. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover stationary engine generator assemblies rated 600 volts or less that are intended for installation and use in ordinary locations in accordance with the National Electrical Code NFPA 70; the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37, the Standard for Health Care Facilities, NFPA 99, and the Standard for Emergency and Standby Power Systems, NFPA 110.

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

1.3 These requirements do not cover UPS equipment. That equipment is covered by the Standard for Uninterruptible Power Systems, UL 1778.

1.4 These requirements do not cover engine generator assemblies for marine use.

1.5 These requirements do not cover snow loading, wind loading, or seismic forces.

2 Glossary

2.1 In the text of this standard, the term ″unit″ refers to any product covered by this standard; for example, engine module, generator module, generator assembly, etc. For the purpose of this standard, the definitions in 2.2 - 2.46 apply.

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

2.2.1 AUTOMATIC SAFETY SHUTOFF VALVE (ASSV) – A device consisting of a valve and operator that controls the gas supply to the engine. The operator may be actuated by the application of gas 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.

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2.2.2 AUTOMATIC VALVE – A valve which controls the flow of gas to the engine during normal operation, and will automatically shut off the flow of gas to the engine in case the engine stops for any cause. Automatic valves include zero governor type regulating valves and auxiliary valves.

Adapted from ANSI Z21.21-2012 Part VI with permission of CSA Group.

2.2.3 AUXILIARY VALVE – A control valve that will automatically close to stop the flow of gas to the engine in the event the engine stops.

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2.3 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 2.34 – 2.36.

2.4 BATTERY CASE/COVER – The container that directly encloses and confines the electrolyte of a battery or cell.

2.5 BATTERY, VALVE-REGULATED – A battery in which the venting of the products of electrolysis is controlled by a reclosing pressure-sensitive valve.

2.6 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.″

2.7 BUS BAR – A conductor or an assembly of conductors for collecting electric currents and distributing them to outgoing feeders.

2.8 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.

2.9 CLASS 1 POWER LIMITED CIRCUIT – A circuit which is supplied from a source having a rated output of not more than 30 volts and 1000 volt-amperes.

2.10 CLASS 2 CIRCUIT – A circuit which is supplied from a Class 2 transformer (see 2.11).

2.11 CLASS 2 TRANSFORMER – A step-down transformer complying with the applicable requirements in the Standard for Low Voltage Transformers - Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

2.12 CLASS 3 CIRCUIT – A circuit which is supplied from a Class 3 Transformer (see 2.11).

2.13 COMPONENT – Refers to subassemblies used in the construction of the generating assembly. See Section 3.

2.14 CONTROL CIRCUIT – A circuit that carries electric signals and not main power current.

2.15 CONTROLLED ENVIRONMENT – An environment that is a conditioned, indoor location such as a computer room, office, or a factory floor that is free of conductive contaminants such as carbon dust and similar material.

2.16 DEDICATED PURPOSE GENERATOR OUTLET / RECEPTACLE – A receptacle used to supply power to specific purpose generator components or accessories such as block heaters, oil heaters, battery chargers, etc.

2.17 ELECTROLYTE – A semisolid, liquid, or aqueous salt solution that permits ionic conduction between positive and negative electrodes of a cell.

2.18 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.

2.19 FIELD-WIRING LEAD – Any lead to which a supply, load, or other wire is intended to be connected by an installer.

2.20 FIELD-WIRING TERMINAL – A terminal to which a supply, load, or other wire is intended to be connected by an installer.

2.21 GENERATOR ASSEMBLY – Refers to the assembly, consisting of the internal combustion engine and generator/alternator.

2.22 GUARD – A part that reduces the risk of access to a component that has the potential of causing an injury to persons.

2.23 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.

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2.24 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:

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a) Secondary winding of a transformer,

b) One or more resistors complying with 25.10, or

c) A regulating network complying with 25.11.

2.25 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.

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

2.27 LOW-VOLTAGE, LIMITED-ENERGY (LVLE) CIRCUIT – A circuit involving an alternating current voltage of not more than 30 volts rms (42.4 volts peak) or a direct current voltage of not more than 60 volts 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 68.3.7.

b) A combination of an isolated transformer secondary winding and one or more resistors or a regulating network complying with 25.11 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 25.11.

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

2.29 MULTI-CELL BATTERY – A battery consisting, internally, of a series or parallel array of two or more cells.

2.30 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.

2.31 PRIMARY CIRCUIT – Wiring and components that are conductively connected to a branch circuit.

2.32 PROTECTED LOAD – Appliances and equipment connected to the alternating current output circuit of unit.

2.33 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 lock and key, or other means of security and is controlled by the authority responsible for the location.

2.34 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 volts or more and either:

a) An available continuous power level of 240 volt-amperes or more, or

b) A reactive energy level of 20 joules 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.

2.35 RISK OF ELECTRIC SHOCK – As defined in Electric Shock, Section 9.

2.36 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 25.4 – 25.12.

2.37 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.

2.38 SAFETY 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.

2.39 SECONDARY CIRCUIT – A circuit supplied from a secondary winding of an isolating transformer. See Section 27.

2.40 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.

2.41 STATIONARY UNIT – An engine generator that is intended to be hard wired and/or permanently installed.

2.42 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.

2.43 SWITCH, TRANSFER - A device for transferring one or more load conductor connections from one power source to another.

2.44 TOOL – A screwdriver, coin, key, or any other object that is used to operate a screw, latch, or similar fastening means.

2.45 USER – Any person other than service personnel.

2.46 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 operator; or

c) The operator 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.

2.47 ZERO GOVERNOR REGULATOR – A fuel regulating device in which pressure is reduced to zero at the fuel inlet to the engine; when a partial vacuum is created in the fuel line, suction will cause the regulator to open, thus allowing flow to the engine as long as the demand continues. This device is also known as a demand type regulator.

3 Components

3.1 Except as indicated in 3.2, a component used as a part of a unit covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

3.2 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.

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

3.4 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.

4 Units of Measurement

4.1 Where a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

5 Undated References

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.

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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 63.2, 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/contactor 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 Insulating Materials, Section 34; or

b) An insulating boot/barrier made from polyvinyl-chloride, neoprene 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 19.11).

Exception: Engines used to carry current shall have voltages that are determined not to be a risk for electric shock, see 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: A meter complying with the requirements in the Standard for Electrical Analog Instruments – Panel Board Types, UL 1437 is not required to comply.

7.2 Enclosures and guards

7.2.1 Whether a 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. The investigation 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 or malfunction of a particular component results in a risk of injury to persons, that component shall be investigated for reliability.

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 means to reduce the risk of unintentional contact therewith.

Exception: A part or portion of a part that is required to be exposed to perform the working function is not required to be enclosed and, when required, guarding shall be provided.

7.2.3 The degree of protection required by 7.2.2 depends upon the general construction and intended use of a unit. 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.

7.2.4 A moving part that involves a risk of injury to persons shall comply with the requirements specified in Protection of Users – Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts – and User Servicing, Section 8, 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.

7.3 Access doors, covers, and panels

7.3.1 An access cover shall be hinged where it provides access to a fuse or other overload-protective device, the functioning of which requires renewal or resetting, or where it is required to open the cover in connection with intended operation of the unit. A means shall be provided to hold the cover closed.

Exception No. 1: A hinged cover 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 amperes or less for loads not exceeding 100 volt-amperes,

c) An extractor fuse having an integral enclosure, or

d) Connected in a low-voltage, limited-energy circuit.

Exception No. 2: A hinged cover is not required for an enclosure that:

a) Contains no user-serviceable or -operable parts, and

b) Is marked in accordance with 68.3.6.

7.3.1.1 Hinged doors, covers, and panels 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 hinged door, cover, or panel to 90 degrees meets the intent of this requirement.

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

7.4 Cast metal enclosures

7.4.1 The thickness of cast metal for an enclosure shall be as specified in Table 7.1.

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.

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Table 7.1
Thickness of cast-metal enclosures

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

[a] The area limitation for metal 1/16 inch (1.6 mm) 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 the Standard for Enclosures for Electrical Equipment, UL 50.

7.5.2 With reference to 7.5.1, the thickness of a sheet-metal enclosure shall not be less than that specified in Tables 7.2 and 7.3. Uncoated steel shall not be less than 0.032 inch (0.81 mm) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 mm) thick, and nonferrous metal shall not be less than 0.045 inch (1.14 mm) 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 Tables 7.2 and 7.3 when investigated and determined to be mechanically equivalent.

Exception No. 2: The thickness of an enclosure may be two gauge sizes less than indicated in Tables 7.2 and 7.3, when uninsulated live parts are located at least 2-1/2 inches (64 mm) from the surface, and 4 gauge sizes less when the uninsulated live parts are located at least 5 in (128 mm) 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 Tables 7.2 and 7.3. 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 7.2
Thickness of carbon steel or stainless steel enclosures

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness inch (mm)			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,					
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Uncoated		Metal Coated	
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited					
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)	0.020[d]	(0.51)	0.023[d]	(0.58)
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited					
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)	0.026[d]	(0.66)	0.029[d]	(0.74)
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited					
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	0.032	(0.81)	0.034	(0.86)
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited					
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)	0.042	(1.07)	0.045	(1.14)
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited					
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)	0.053	(1.35)	0.056	(1.42)

Table 7.2 Continued on Next Page

Table 7.2 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness inch (mm)			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,					
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)	Uncoated		Metal Coated	
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited					
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)	0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited					
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)	0.067	(1.70)	0.070	(1.78)
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited					
38.0	(103.4)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)	0.080	(2.03)	0.084	(2.13)
42.0	(106).7)	Not limited		64.0	(162.6)	Not limited					
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	0.093	(2.36)	0.097	(2.46)
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited					
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	0.108	(2.74)	0.111	(2.82)
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited					
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	0.123	(3.12)	0.126	(3.20)

[a] See 7.5.4 and 7.5.5.

[b] 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.

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

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

Table 7.3
Thickness of aluminum, copper, or brass enclosures

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]					
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length		Minimum thickness	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023[d]	(0.58)
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)		
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0029	(0.74)
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)		
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036	(0.91)
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)		
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045	(1.14)
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)		
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058	(1.47)
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)		
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075	(1.91)
20.0	(50.8)	25.0	(63.4)	45.0	(114.3)	55.0	(139.7)		
25.0	(63.4)	Not limited		60.0	(152.4)	Not limited		0.095	(2.41)
29.0	(73.7)	36.0	(91.4)	64.0	(162.6)	78.0	(198.1)		
37.0	(94.0)	Not limited		87.0	(221.0)	Not limited		0.122	(3.10)
42.0	(106.7)	53.0	(134.6)	93.0	(236.2)	114.0	(289.6)		

Table 7.3 Continued on Next Page

Table 7.3 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				
Maximum width[b]		Maximum length[c]		Maximum width[b]		Maximum length		Minimum thickness
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches (cm)
52.0	(132.1)	Not limited		123.0	(312.4)	Not limited		0.153 (3.89)
60.0	(152.4)	74.0	(188.0)	130.0	(330.2)	16.0	(406.4)	

[a] See 7.5.4 and 7.5.5

[b] 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.

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

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

7.5.3 Tables 7.2 and 7.3 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 Tables 7.2 and 7.3, 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.

7.5.5 With reference to 7.5.4 and Tables 7.2 and 7.3, 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 shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.6.2 A nonmetallic part that forms part of the enclosure 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 1 inch (25.4 mm) 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 prohibits access to live parts involving a risk of fire, electric shock, or electric energy– high current levels – or moving parts to the user when the part is removed.

c) The part covers an opening that has no dimension greater than 4 inches (101.6 mm) 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 2.36) closer than 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 clarifications shall be in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, 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 flammability class applicable to the component.

7.6.3 A polymeric material enclosure having in any single unbroken section, a projected surface area greater than 10 square feet (0.93 m^2), or a single linear dimension greater than 6 feet (1.83 m) shall have a flame-spread rating of 200 or less when tested in accordance with the:

a) Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or

b) Radiant-panel furnace method in the Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162.

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 the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, 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 UL 746C.

7.7 Glass covered openings

7.7.1 Glass covering an opening shall be secured in place so that it is not readily displaced in service, and provides mechanical protection for the enclosed parts. Glass for an opening shall comply with the following dimensions:

a) Glass for an opening not more than 4 inches (102 mm) in any dimension shall not be less than 1/16 inch (1.6 mm) thick,

b) Glass for an opening not more than 144 square inches (929 cm^2) in area and having no dimension greater than 12 inches (305 mm) shall not be less than 1/8 inch (3.2 mm) thick, and

c) Glass used to cover an area larger than noted in (b) shall not be less than 1/8 (3.2 mm) inch thick and shall:

1) Be of a nonshattering or tempered type that, when broken, complies with the Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test, ANSI Z97.1, or

2) Be subjected to the test described in 63.1.1.

7.8 Openings for wiring

7.8.1 The requirements described in 7.8.2 – 7.8.9 apply to fixed units.

7.8.2 Where threads for the connection of conduit are tapped all the way through a hole in an enclosure wall or where an equivalent construction is employed, there shall not be less than three nor more than five threads in the metal, and the construction of the enclosure shall be such that a conduit bushing is capable of being properly attached. Where threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or similar device, there shall not be less than 3-1/2 threads in the metal and there shall be a smooth, rounded inlet hole for the conductors equivalent to that provided by a standard conduit bushing with an internal diameter the same as that of the corresponding trade size of rigid conduit.

7.8.3 Clamps and fasteners for the attachment of conduit, electrical metallic tubing, armored cable, nonmetallic flexible tubing, nonmetallic-sheathed cable, service cable, and similar devices that are supplied as a part of an enclosure shall comply with the Standard for Metallic Outlet Boxes, UL 514A, and the Standard for Conduit, Tubing, and Cable Fittings, UL 514B.

7.8.4 A knockout in a sheet-metal enclosure shall be secured and shall be removable without undue deformation of the enclosure.

7.8.5 A knockout shall be provided with a flat surrounding surface intended for proper seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout to be used during installation does not result in spacing between an uninsulated live part and the bushing to be less than that specified in Spacings, Section 24.

7.8.6 In measuring a spacing between an uninsulated live part and a bushing installed in a knockout as specified in 7.8.5, it is to be assumed that a bushing having the dimensions specified in Table 7.4 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 7.4
Knockout or hole sizes and dimensions of bushings

Trade size of conduit	Knockout or hole diameter		Bushing dimensions			
			Overall diameter		Height	
Inches	Inches	mm	Inches	mm	Inches	mm
1/2	7/8	22.2	1	25.4	3/8	9.5
3/4	1-3/32	27.8	1-15/64	31.4	27/64	10.7
1	1-23/64	34.5	1-19/32	40.5	33/64	13.1
1-1/4	1-23/32	43.7	1-15/16	49.2	9/16	14.3
1-1/2	1-31/32	50.0	2-13/64	56.0	19/32	15.1
2	2-15/32	62.7	2-45/64	68.7	5/8	15.9
2-1/2	3	6.2	3-7/32	81.8	3/4	19.1
3	3-5/8	92.1	3-7/8	98.4	13/16	20.6
3-1/2	4-1/8	104.8	4-7/16	112.7	15/16	13.8
4	4-5/8	117.5	4-31/32	126.2	1	25.4
4-1/2	5-1/8	130.2	5-35/64	140.9	1-1/16	27.0
5	5-5/8	42.9	6-7/32	158.0	1-3/16	30.2
6	6-3/4	171.5	7-7/32	183.4	1-1/4	31.8

7.8.7 For an enclosure not provided with conduit openings or knockouts, spacings not less than the minimum specified in Spacings, Section 24 shall be provided between uninsulated live parts and a conduit bushing installed at any location to be used during installation. Permanent marking on the enclosure, a template, or a drawing furnished with the unit is used to specify such a location. The specified location of the openings shall be such that damage to internal parts shall not result when openings are made.

7.8.8 With respect to the requirement in 7.8.7, means shall be provided so that an opening for conduit is capable of being made without subjecting internal parts to contamination resulting from the presence of metallic particles. Compliance with this requirement is accomplished by the use of a removable, bolted plate.

7.8.9 A polymeric- or metal-closure plug for an unused conduit opening shall comply with the requirements in the Standard for Metallic Outlet Boxes, UL 514A.

7.9 Openings in an enclosure

7.9.1 The enclosure of a unit shall be designed and constructed to reduce the risk of emission of flame, molten metal, flaming or glowing particles, or flaming drops.

7.10 Enclosure bottom openings

7.10.1 A complete noncombustible bottom or a construction employing individual noncombustible barriers under components, groups of components, or assemblies, as specified in Figure 7.1 is required in accordance with 7.9.1.

Exception No. 1: Ventilating openings in the bottom panel are not prohibited when noncombustible baffle plates are provided to reduce the risk of materials from falling directly from the interior of the unit onto the supporting surface or any other location under the unit. An example of such a baffle is illustrated in Figure 7.2.

Exception No. 2: Ventilation openings in the bottom of an enclosure are not prohibited when the openings incorporate a perforated metal plate as described in Table 7.5, or a galvanized or stainless steel screen having a 14- by 14-mesh per inch (25.4-mm) constructed of wire with a diameter of 0.018 inch (0.4 mm) minimum.

Exception No. 3: Other constructions complying with the hot, flaming oil test in Ignition Test Through Bottom Panel Openings, Section 65, need not comply with this requirement.

Exception No. 4: The bottom of the enclosure under areas containing only materials classed V-1 or better in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, shall have openings no larger than 1/4 inch (6.4 mm) square. Openings that are not square shall not have an area greater than 1/16 square inch (40 mm^2).

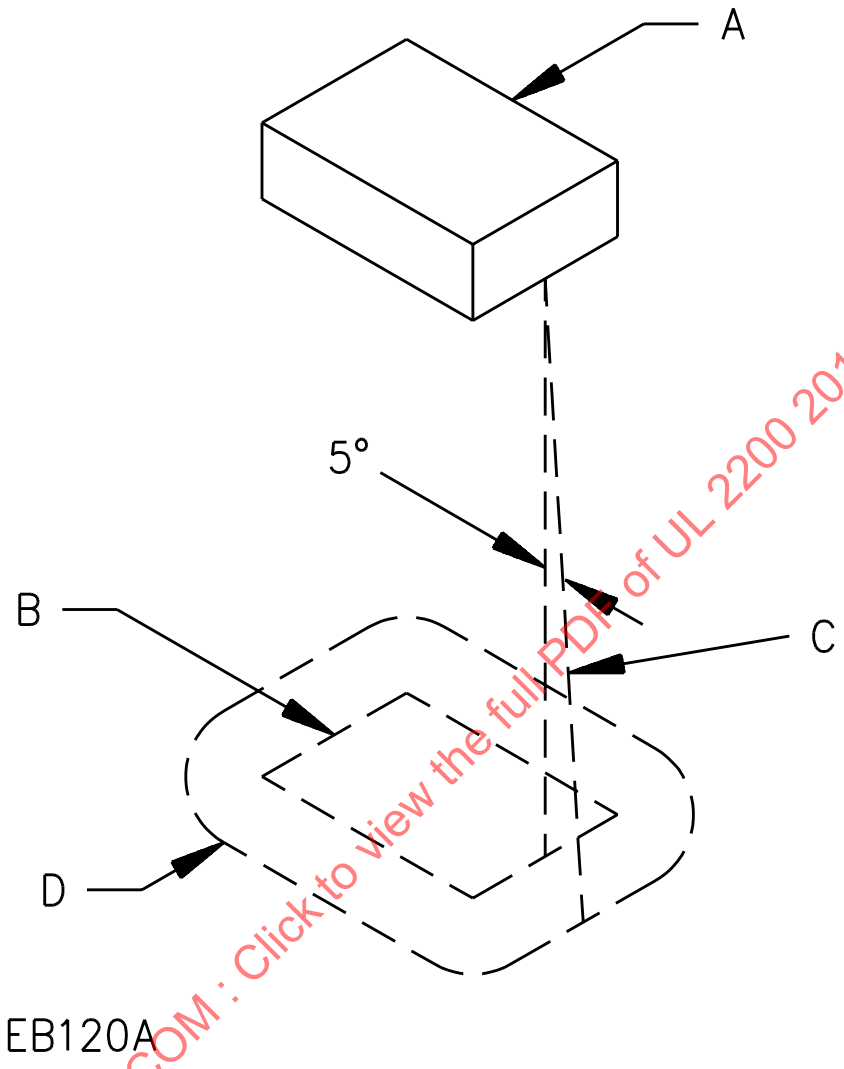
Exception No. 5: Ventilating openings without limitation on their size and number and complying with 8.12 and provided in the bottom panel are not prohibited when in areas that contain only wires, cables, plugs, receptacles, transformers, and impedance protected or thermally protected motors.

Exception No. 6: Ventilating openings are not prohibited in the bottom panel when:

a) The installation instructions state that the generator assembly shall be installed over non combustible materials, and

b) The generator assembly is located such that it prevents combustible materials from accumulating under the generator set.

Figure 7.1
Enclosure bottom



A – Region to be shielded by barrier. This consists of the entire component when it is not otherwise shielded, and of the unshielded portion of a component which is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line which traces out minimum area of barrier. When moving, the line is always:

1) Tangent to the component,
2) Five degrees from the vertical, and
3) So oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

Figure 7.2
Example of a bottom-enclosure baffle

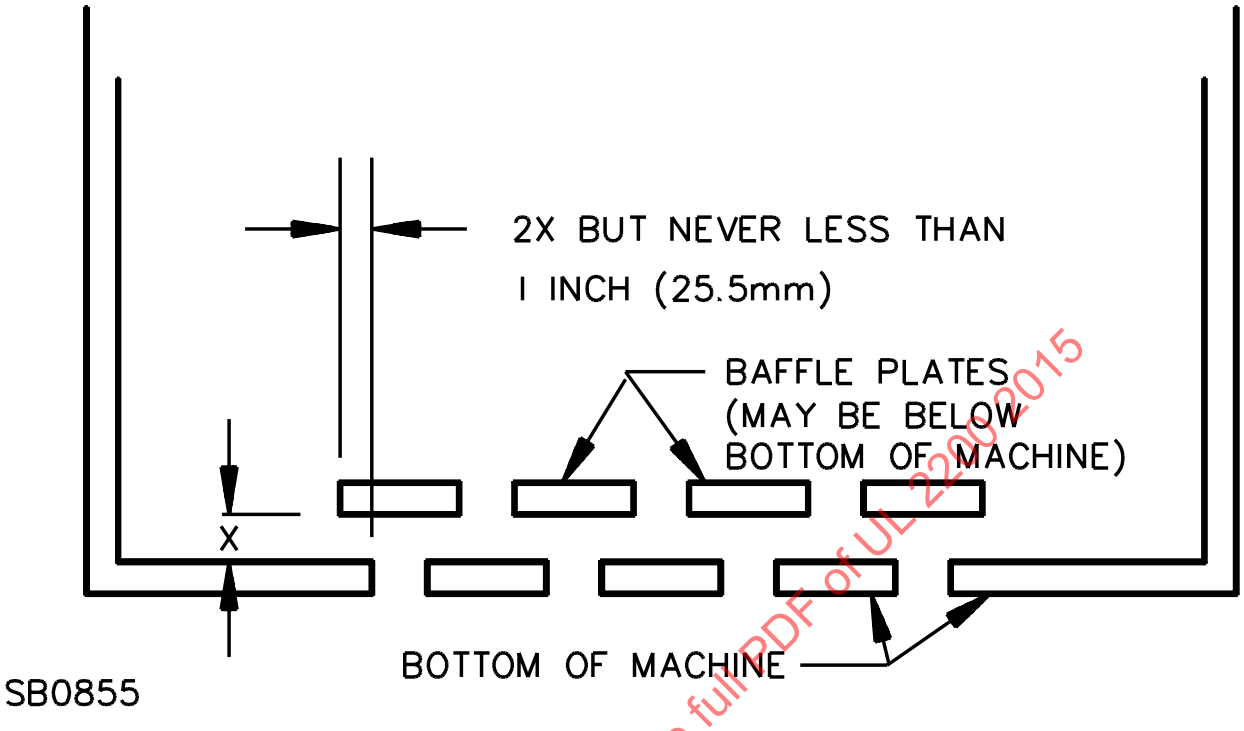


Table 7.5
Perforated metal plates for enclosure bottom

Minimum thickness		Maximum diameter of holes		Minimum spacings of holes center to center	
inch	(mm)	inch	(mm)	inch	(mm)
0.026	(0.66)	0.045	(1.14)	0.067	(1.70)
				233 holes per inch^2 (645 mm^2)	
0.026	(0.66)	0.047	(1.19)	0.093	(2.36)
0.030	(0.76)	0.045	(1.14)	0.067	(1.70)
0.030	(0.76)	0.047	(1.19)	0.093	(2.36)
0.032	(0.81)	0.075	(1.91)	0.125	(3.18)
				72 holes per inch^2 (645 mm^2)	
0.035	(0.89)	0.075	(1.90)	0.125	(3.18)
0.036	(0.91)	0.063	(1.60)	0.109	(2.77)
0.036	(0.91)	0.078	(1.98)	0.125	(3.18)
0.039	(0.99)	0.063	(1.60)	0.109	(2.77)
0.039	(0.99)	0.079	(2.00)	0.118	(3.00)

Note – In accordance with Exception No. 2 to 7.10.1.