



UL 2201

Underwriters Laboratories Inc. Standard for Safety

Portable Engine-Generator Assemblies



*UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL*



Documents
Document Sharing Hub

UL Standard for Safety for Portable Engine-Generator Assemblies, UL 2201

First Edition, Dated March 4, 2009

Summary of Topics

This revision to the Standard for Portable Engine-Generator Assemblies, UL 2201, includes the following changes in requirements:

- 1. Revise Muffler After Fire Test (Section 27) requirements and delete Alternate Muffler Test (Section 28)***
- 2. Add new Reverse Polarity Test (Section 41A) requirements***
- 3. Remove requirements for the relief vent test for non-vented caps (Section 18.8.2)***
- 4. Revise Table 18.1 to include vapors with test liquids for nonmetallic materials***
- 5. Clarify requirements for backfire and after fire requirements for carburetors in Section 7***
- 6. Clarify enclosure requirements for corrosion protection in 6.1.2***
- 7. Add positive shutoff requirement for tanks and pumps***
- 8. Delete requirement for motor location in 6.7.1 and update reference to UL 1004-4 in 15.4.1***
- 9. Revise requirement for the internal pressure resistance test***

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. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 28, 2010.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

MARCH 4, 2009

(Title Page Reprinted: February 28, 2011)

1

UL 2201

Standard for Portable Engine-Generator Assemblies

First Edition

March 4, 2009

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>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

COPYRIGHT © 2011 UNDERWRITERS LABORATORIES INC.

**UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL**



Documents
Document Sharing Hub

No Text on This Page

*UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL*



Documents

Document Sharing Hub

CONTENTS

INTRODUCTION

1 Scope	7
2 General	8
2.1 Units of measurement	8
2.2 Undated references	8
3 Glossary	8
4 Components	9
5 Instructions and Drawings	10

CONSTRUCTION

6 Protection Against Personal Injury	10
6.1 Enclosures and guards	10
6.2 Accessibility of live parts	15
6.3 Sharp edges	16
6.4 Nonmetallic parts	16
6.5 Gaskets	17
6.6 Foamed materials (sound insulation)	17
6.7 Motors	17

MECHANICAL SYSTEM

7 Fuel Systems – Gasoline and Diesel	17
7.1 Tanks and pumps	17
7.2 Fuel lines and fittings	18
7.3 Corrosion resistance	19
7.4 Carburetors	19
8 Fuel Systems – Liquefied Petroleum Gas	19
8.1 General	19
8.2 Containers	20
8.3 Gauges	21
8.4 Fuel lines and fittings	22
8.5 Vaporizers	23
8.6 Safety control and relief devices	23
8.7 Nonmetallic parts	24
8.8 Corrosion resistance	25
9 Exhaust System	25

ELECTRICAL SYSTEM

10 Enclosure	25
10.1 General	25
10.2 Batteries	26
11 Electric Shock	27
11.1 Voltage	27
11.2 Stored energy	27
12 Low Voltage Limited Energy Circuit	28
13 Assembly	29
14 Wiring	29

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM  **Documents**
Document Sharing Hub

14.1	Factory wiring	29
14.2	Internal wiring over 50 V	30
14.3	Segregation of circuits	32
15	Electrical Components	32
15.1	Live parts	32
15.2	Printed-wiring boards	33
15.3	Insulating material	33
15.4	Generator heads	36
15.5	Capacitors	36
15.6	Resistors	36
15.7	Receptacles and ground fault circuit interrupter protection	36
15.8	Output alternating current (AC) power circuit protection	37
15.9	Output direct current (DC) power circuit protection	37
15.10	Generator protection	38
15.11	Switches	38
15.12	Protective devices	38
15.13	Engine generator controls	38A
15.14	Integral meters	39
15.15	Shut-off means	39
15.16	Flexible cords	39
15.17	Battery chargers	39
16	Grounding and Bonding	39
16.1	General	39
16.2	Integral parts	41
16.3	Generator frame	42
16.4	Grounding electrode conductor terminal	42
17	Spacings	43
17.1	Factory wiring	43
17.2	Barriers and liners	44

PERFORMANCE

ALL UNITS

18	Nonmetallic Fuel Tank Tests	44
18.1	General	44
18.2	1000-Hour Xenon exposure test	44
18.3	Air oven aging test	45
18.4	Nonmetallic fuel tanks low temperature test	45
18.5	Fuel tank internal pressure resistance test	45
18.6	Stress cracking test for blow-molded or nonmetallic rotationally-molded containers	46
18.7	Tests of nonmetallic materials	46
18.8	Component tests	48
18.9	Overspill test	48
19	Temperature Test	49
20	Impact Tests	55
20.1	General	55
20.2	Drop impact test	55
20.3	Ball impact test	56
21	Mold Stress-Relief Distortion Test	58
22	Physical Stability Test	59
23	Mechanical Load Test	60
24	Lifting Means and Handle Strength Test	60

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL



Documents
Document Sharing Hub

25 Vibration Measurement Test	61
26 Ground Fault Circuit Interrupter Evaluation and Durability Test	61

MECHANICAL SYSTEMS

27 Muffler After Fire Test	67
28 Alternate Muffler Test	68
29 Intake Backfire Test	68
30 Hydrostatic Strength Test for Nonmetallic Fuel Hose Assemblies Used on the Outlet Side of the Fuel Pump	68
31 10-Day Moist Ammonia-Air Stress Cracking Test for Brass Parts Exposed to Fuel	68
32 Tube-Fitting and Hose Connection Pull Test	69
33 Tests on LP-Gas Fuel Lines and Fittings	70
33.1 Pressure test	70
33.2 Torque test	70
34 LP-Gas Container Load Tests	71
35 Overspeed Test	71

ELECTRICAL SYSTEMS

36 Harmonic Distortion Test	71
37 Variation in Output Voltage and Frequency Test	71
38 Dielectric Voltage Withstand Test	72
39 Overcurrent Tests	72
39.1 General	72
39.2 Overload test	72
39.3 Output short circuit test	73
40 Component Short- and Open-Circuit Test	73
41 Direct Current Output Circuit Capacity Test	73
41A Reverse Polarity Test	74

ENVIRONMENTAL

42 Metallic Coating Thickness Test	74
43 Rain Test	75
44 Sprinkler Test	78
45 Gasket Tests	80
45.1 Tensile strength and elongation tests	80
45.2 Oil immersion test	80

MANUFACTURING AND PRODUCTION TESTS

46 General	80
47 Dielectric Voltage Withstand Test	80
48 Generator Output Measurements and Ground Fault Circuit Interrupter (GFCI) Operation ...	81

RATINGS

49 Details	81
------------------	----

MARKING

50 Details	82
50.1 General	82
50.2 Content	83
50.3 Danger, Warning, and Cautionary markings	86
51 Instruction Manual	90
51.1 General	90
51.2 Operating instructions	93

APPENDIX A

Standards for Components.....	A1
-------------------------------	----

INTRODUCTION

1 Scope

1.1 These requirements address the electric shock, fire, and casualty aspects associated with the mechanical performance and the electrical features of portable engine-driven generator assemblies.

1.2 These requirements cover internal combustion engine-driven generators rated 15 kW or less, 250 V or less, which are provided only with receptacle outlets for the AC output circuits. The generators may incorporate alternating or direct current generator sections for supplying energy to battery charging circuits.

1.3 Generators covered by this standard are normally used by persons other than service personnel.

1.4 These requirements cover open ventilated generators having ventilating openings that permit the passage of external cooling air over or around the windings, or both.

1.5 These requirements cover generator components and combinations of such components.

1.6 These requirements do not cover generators for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.7 These requirements do not cover generators for marine use. That equipment is covered by the Standard for Marine Electric Motors and Generators, UL 1112.

1.8 These requirements do not cover generators intended for installation in recreational vehicles. That equipment is covered by the Standard for Engine-Generator Assemblies for Use in Recreational Vehicles, UL 1248.

1.9 These requirements do not cover generators intended for stationary use. That equipment is covered by the Standard for Stationary Engine Generator Assemblies, UL 2200.

1.10 These requirements do not cover generator assemblies as part of welding and plasma cutting machines. That equipment is covered by the Standard for Safety for Transformer-Type Arc-Welding Machines, UL 551, or the Standard for Arc Welding Equipment; Part 1: Welding Power Sources, UL 60974-1.

1.11 These requirements cover products fueled by flammable and combustible liquids such as gasoline and diesel fuel, including gasoline with small amounts of additives such as detergents, solvents for detergents and anti-icing chemicals, and gasoline with up to 15% ethanol or methyl tertiary butyl ether (MTBE).

2 General

2.1 Units of measurement

2.1.1 Where values are followed by other values in parentheses, the use of either value will provide equivalent results in the application of the requirements.

2.2 Undated references

2.2.1 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.

3 Glossary

3.1 The terms “generator,” “unit,” and “product,” as used in this standard, refer to any equipment covered by this standard. For the purpose of this standard, the definitions in 3.2 – 3.19 apply.

3.2 BATTERY CHARGING CIRCUIT – A nominally 12V DC circuit intended only for charging the generator starting battery with peak voltage below 21V.

3.3 CARRYING/TRANSPORT POSITION – The position of the generator as it is being moved.

3.4 DIRECT CURRENT (DC) – A voltage or current waveform in which the instantaneous value does not vary.

3.5 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.

3.6 FRAME – A structure of angle, channel, or a folded rigid section of material assembled to resist bending, provided to support components of the generator.

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

3.8 INSTRUCTION MANUAL – This term is interchangeable with the term “users manual.”

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

3.10 LOW-VOLTAGE LIMITED-ENERGY (LVLE) CIRCUIT – A circuit with an open-circuit potential of not more than 21.2 V peak AC, or 30 V DC, with the energy available to the circuit limited:

- a) So that the current under any condition of load including short circuit is not more than 8 A for potentials up to 21.2 V peak, and measured after 1 minute of operation by:

- 1) Inherent design of the engine.
- 2) A fixed impedance or reliable regulating network; or

b) By a fuse or nonadjustable manually reset circuit protective device that is rated or set at not more than the value specified in Table 12.1.

3.11 PORTABLE – A generator in accordance with the Scope, Section 1, which is intended to be moved for temporary use and is not intended for permanent stationary installation.

3.12 PROTECTIVE FRAME – The box outline of the frame structure of the generator.

3.13 PULSATING DIRECT CURRENT (DC) – A direct current (DC) that changes in value at regular or irregular intervals.

3.14 RATED OUTPUT – The maximum continuous amps, watts or kilowatts, or volt-amps or kilo-volt-amps that are declared with a marking by the manufacturer and that the machine is capable of sustaining in a steady-state condition.

3.15 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist if the voltage between parts exceeds the value specified in Electric Shock, Section 11.

3.16 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.

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

3.18 USER – Any person other than service personnel who may not recognize potential danger associated with the use of a generator.

3.19 VOLTAGE OR VOLTS – An electrical potential. Unless otherwise noted, "voltage," "volts," or "V" as used in this standard refers to the root mean square (rms) measurement of alternating current (AC) voltage.

4 Components

4.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the Standards for Components appendix for a list of standards covering components generally used in the products covered by this standard.

4.2 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.

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

4.4 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.

5 Instructions and Drawings

5.1 Operating instructions in accordance with the requirements of Instruction Manual, Section 51, shall be furnished with each product.

CONSTRUCTION

6 Protection Against Personal Injury

6.1 Enclosures and guards

6.1.1 General

6.1.1.1 Hazardous moving parts shall be guarded so as to adequately reduce the risk of injury to persons during normal operation, setting of any adjustments, and maintenance of the product.

6.1.1.2 The following factors shall be considered in judging whether guarding for hazardous moving parts is adequate:

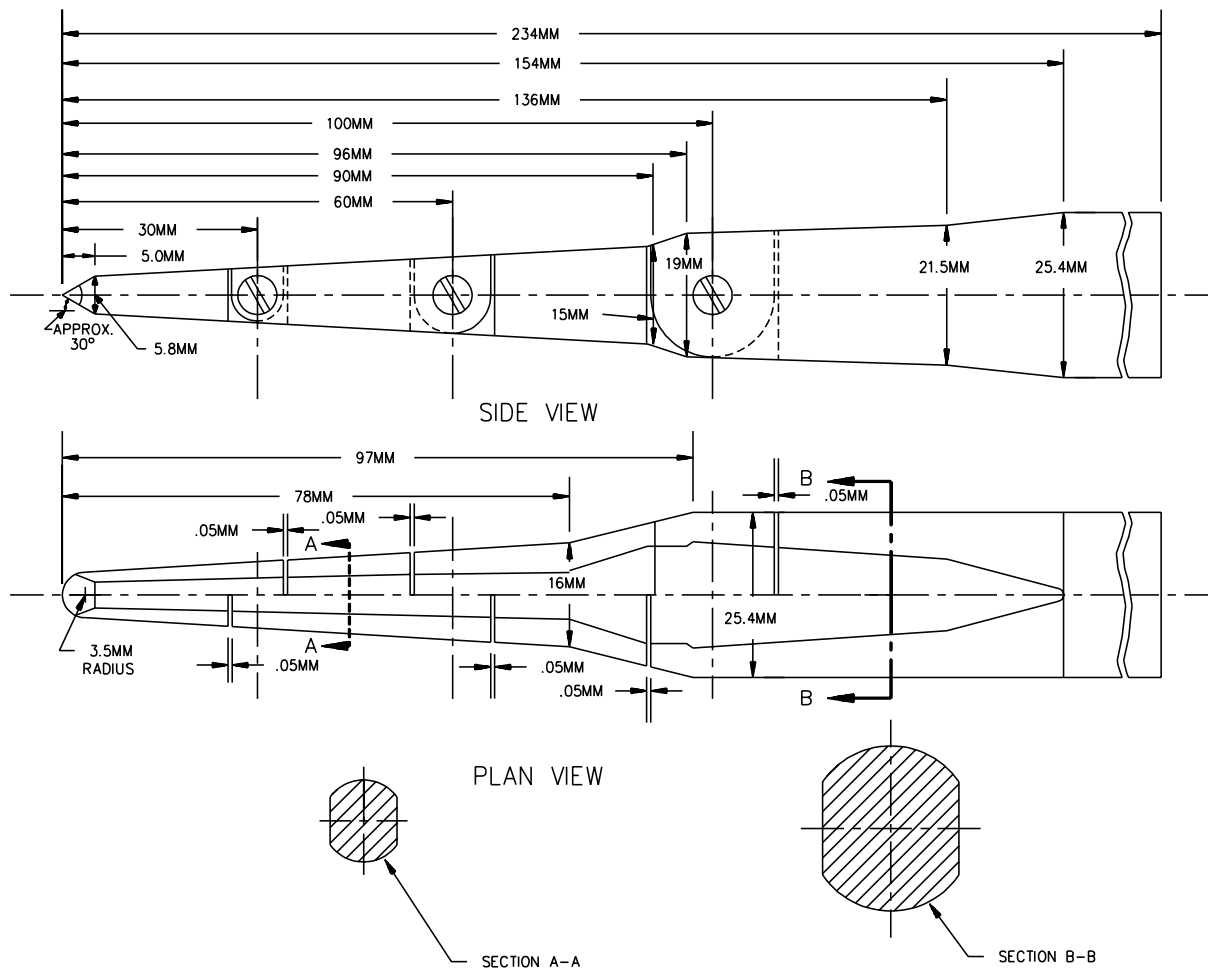
- a) Degree of exposure to the moving part,
- b) Sharpness, speed, and mass of the moving part, and
- c) Likelihood of accidental contact or entanglement with fingers, arms, feet, or clothing with the moving part.

6.1.1.3 Features of guards to be considered include:

- a) Removability of the guard with the use of tools.
- b) Removability for servicing and the need for replacement.
- c) Strength and rigidity.
- d) Completeness.
- e) Creation of risks of personal injury, such as pinch points, and the necessity for additional handling because of increased need for servicing (such as cleaning).

6.1.1.4 An opening in a guard or enclosure for hazardous live parts shall not permit the probe illustrated in Figure 6.1 to contact the part when inserted through the opening with a force of 1 lbf (4.4 N) to its maximum depth and in a straight or articulated position.

Figure 6.1
Articulated probe



PA100

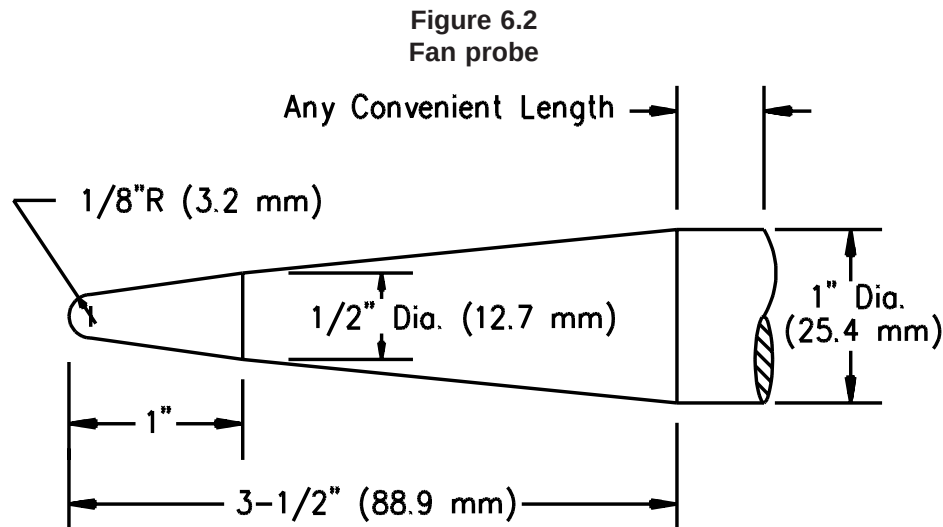
Probe available from Underwriters Laboratories Inc.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL



Documents
Document Sharing Hub

6.1.1.5 The hazardous portion of all moving parts shall be so guarded that the probe illustrated in Figure 6.2 will not contact a hazardous part when inserted through any opening in the guard and applied with a force of 1 lbf (4.4 N).



PA 160

6.1.2 Protection against corrosion

6.1.2.1 All materials, including hinges, guards, non-electrical enclosures, and frames formed of iron or steel, shall be protected against corrosion by painting, galvanizing, plating or by other equivalent means.

6.1.2.1 revised February 28, 2011

6.1.2.2 The requirement in 6.1.2.1 does not apply to bearings, laminations, or minor parts such as washers and screws, nor does it apply to a part where other specific requirements for materials or corrosion protection are noted.

6.1.2.3 Metals used in combinations shall be galvanically compatible.

6.1.2.4 Steel electrical enclosures shall be protected against corrosion by one of the following coatings:

- a) Hot-dipped mill-galvanized steel conforming with the coating Designation G90 in Table I of ASTM Designation A525, with not less than 40% of the zinc on any side, based on the minimum single-spot test requirement in this ASTM designation. The weight of the zinc coating may be determined by any acceptable method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM Designation A90. See 6.1.2.7 and 6.1.2.8;

- b) A zinc coating, other than that provided on hot-dipped mill-galvanized steel, uniformly applied to an average thickness of not less than 0.00061 in (0.015 mm) on each surface with a minimum thickness of 0.00054 in (0.014 mm). The thickness of coating shall be established by the metallic coating thickness test described in ASTM Designation B555. An annealed coating shall comply with 6.1.2.5 and 6.1.2.6;
- c) A zinc coating conforming with 6.1.2.4(c)(1) or 6.1.2.4(c)(2) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint applied after forming on each surface. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary:
- 1) Hot-dipped mill-galvanized steel conforming with the coating Designation G60 or A60 in Table I of ASTM Designation A525, with not less than 40% of the zinc on any side, based on the minimum single-spot test requirement in this ASTM designation. The weight of zinc coating may be determined by any acceptable method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM Designation A90;
 - 2) A zinc coating, other than that provided on hot-dipped mill-galvanized steel, uniformly applied to an average thickness of not less than 0.00041 in (0.010 mm) on each surface with a minimum thickness of 0.00034 in (0.009 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 42;
- d) A nickel coating having a thickness of not less than 0.00015 in (0.0038 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 42;
- e) A tin over nickel coating having an overall thickness of not less than 0.00015 in (0.0038 mm). The thickness of coating shall be established by the Metallic Coating Thickness Test, Section 42;
- f) Other finishes, such as special metallic finishes, or metallic finish combined with paint may be accepted when comparative tests with galvanized steel (without annealing, wiping, or other surface treatment) conform with 6.1.2.4(a) or, when found to provide equivalent protection after exposure to both of the following:
- 1) A 600-hr salt spray test conducted in accordance with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332, and
 - 2) A 1200-hr moist carbon-dioxide sulphur-dioxide air mixtures test conducted in accordance with UL 1332;
- g) Paint may be accepted when the applicable requirements for UL 1332, indicate that it provides equivalent protection.

6.1.2.4 revised February 28, 2011

6.1.2.5 An annealed coating on steel that is bent or similarly formed or extruded or rolled at edge of holes after annealing shall be additionally painted in the affected area if the process damages the zinc coating. See 6.1.2.4(b).

6.1.2.6 If flaking or cracking of the zinc coating, on steel, at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered to be damaged. Simple sheared or cut edges and punched holes are not required to be additionally protected. See 6.1.2.4(b).

6.1.2.7 A hot-dipped mill-galvanized G90 coating, on steel, shall not be damaged during handling or fabrication to the extent that the base metal is exposed. See 6.1.2.4(a).

Exception No. 1: Uncoated cross-sectional surfaces at cut edges and drilled or punched openings are acceptable.

Exception No. 2: The base metal may be exposed if:

- a) The maximum width and length of the exposed metal does not exceed the thickness and length of any cut edge on the sheet, or*
- b) The surface has one coat of an organic finish of the epoxy or alkyd-resin type, or other outdoor paint applied after fabrication.*

6.1.2.8 Steel that employs a hot-dipped mill-galvanized G90 coating that is drawn, formed, extruded, or rolled shall be additionally painted with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint in the areas that are affected by a process that damages the coating as determined by the requirement in 6.1.2.6. See 6.1.2.4(a).

6.1.2.9 Copper, bronze, brass containing at least 80% copper, or stainless steel may be used without additional protection against corrosion. Other metal shall be a grade or alloy known to be non-susceptible to corrosion, or shall be subjected to appropriate tests, additionally protected against corrosion, or both.

6.1.2.10 All sheet, extruded, or cast aluminum alloys may be used without additional protection against corrosion.

6.1.2.11 An enclosure of cast iron or malleable iron at least 1/8 in (3.2 mm) thick shall be protected against corrosion by:

- a) A 0.00015 in (0.0038 mm) thick coating of zinc or the equivalent, on the outside surface and a visible coating of such metal on the inside surface, or
- b) One coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint may be determined by consideration of its composition or, if necessary, by corrosion tests.

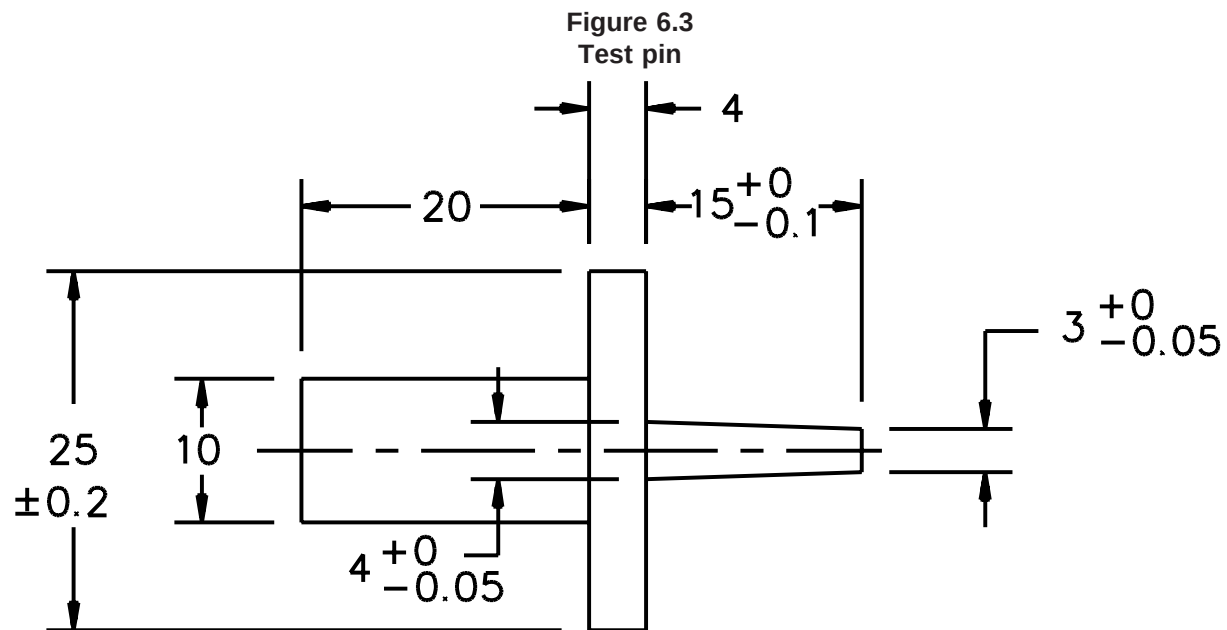
6.2 Accessibility of live parts

6.2.1 General

6.2.1.1 A live part that presents a risk of electric shock shall be located or enclosed so that protection against contact is provided.

6.2.1.2 The input impedance of the voltmeter used to measure voltage in accordance with the requirements of 6.2.2.2 is to be a minimum of 1 M Ω . The input impedance of a meter with more than 1 M Ω input impedance can be lowered by using shunt impedance.

6.2.1.3 A guard, baffle, or cover that can be removed without using a tool is to be removed when determining if a live part is accessible to the user. A live part that can be contacted by the articulated probe illustrated in Figure 6.1 or test pin illustrated in Figure 6.3 is considered to be accessible.



S2962

Dimensions in millimeters

6.2.2 Protection of users to live parts

6.2.2.1 The articulated probe and test pin illustrated in Figure 6.1 and Figure 6.3, respectively, when applied as described in 6.2.2.3, shall not contact any live part with a voltage greater than that specified in 6.2.2.2 with respect to the chassis or any other live part simultaneously accessible, in a different location, to the test pin or articulated probe.

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL



Documents
Document Sharing Hub

6.2.2.2 The maximum voltages which may be accessible in accordance with 6.2.2.1 are:

- a) 21.2 V peak for sinusoidal or nonsinusoidal DC,
- b) 30 V for continuous DC, and
- c) 12.4 V peak for DC interrupted at a rate of 200 Hz or less with approximately 50% duty cycle.

Exception: The voltage limits specified may be exceeded if the current through a 1500 Ω resistor connected between the accessible points does not exceed 0.5 mA.

6.2.2.3 The articulated probe and test pin referenced in 6.2.2.1 are to be applied with a force not exceeding 1 lbf (4.4 N) to determine whether the live parts are accessible. The test pin shall not be applied to fuseholders and the like.

6.3 Sharp edges

6.3.1 An edge, a projection, and a corner of an enclosure, frame, guard, handle, or the like, shall be smooth and rounded, and not sufficiently sharp to constitute a risk of injury to persons in normal maintenance and use of a product.

6.3.2 Whenever referee measurements are necessary to determine that a part as mentioned in 6.3.1 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the requirements for determination of sharpness of edges on equipment in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be employed. See 14.2.7 for sharp edge requirements as they apply to potential damage to conductors.

6.4 Nonmetallic parts

6.4.1 Nonmetallic parts shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Applicable requirements are those for “all other portable equipment,” including requirements for outdoor use.

Exception: This requirement does not apply to parts used for ornamental purposes only and not as an enclosure or insulation of electrically live parts.

6.5 Gaskets

6.5.1 Gasket material used to prevent the entrance of water during the Rain Test, Section 43, or the Sprinkler Test, Section 44, shall comply with the Gasket Tests, Section 45.

6.6 Foamed materials (sound insulation)

6.6.1 Foamed materials, if provided, shall have a flame rating of V-2 minimum or equivalent.

6.7 Motors

6.7.1 *Deleted February 28, 2011*

MECHANICAL SYSTEM

7 Fuel Systems – Gasoline and Diesel

7.1 Tanks and pumps

7.1.1 A fuel tank provided as part of the engine-generator assembly shall be nonmetallic or constructed of painted mild steel having a minimum thickness of 0.030 in (0.76 mm) or of material equivalent in strength, rigidity, and resistance to fire and corrosion. The joints shall be welded, brazed, soldered, or bonded. If soldered or bonded, the joints shall be of a construction which will retain the heads if the solder or bonding melts. Fittings and fill pipe, if soldered or bonded, shall be mechanically secured to the tank in addition to soldering or bonding.

7.1.2 Nonmetallic fuel tanks shall be subjected to Nonmetallic Fuel Tank Tests, Section 18.

7.1.3 When a tank is integral to the generator, the facilities for filling shall be such that spillage or leakage will be held captive or drain to the ground and not onto the electrical- or exhaust-system components. An Overspill Test (see 18.9) shall be conducted when the design of the engine-generator assembly may permit fuel to spill onto the engine compartment.

7.1.4 External fuel-confining parts of a fuel pump shall be of metal. Electrically-operated fuel pumps shall comply with the requirements of the Standard for Safety for Industrial Trucks, Internal Combustion Engine-Powered, UL 558.

7.1.4.1 A positive shutoff shall be provided in gravity-fed systems between the outlet of the fuel tank and the inlet of the carburetor. In the closed position, it shall prevent fuel from flowing at 3 lbs per square in (psi) (20.7 kPa) or less.

7.1.4.1 added February 28, 2011

7.1.5 A positive shutoff shall comply with the requirements for safety valves of the Standard for Electrically Operated Valves, UL 429, and shall prevent fuel at 3 lbs per square in (psi) (20.7 kPa) or less from flooding the carburetor and spilling when the engine-generator is not operating.

7.2 Fuel lines and fittings

7.2.1 Metal fuel lines shall be of annealed seamless drawn aluminum, steel, copper tubing, flexible tubing or hose. Flexible tubing or hose shall comply with the Standard for Fuel and Oil Hoses, SAE J30, and shall be tested in accordance with 32.1.

7.2.2 Aluminum tubing shall have a nominal wall thickness of not less than 0.030 in (0.0035 in minus tolerance) [0.76 mm (0.089 mm minus tolerance)].

7.2.3 Copper tubing shall have a nominal wall thickness of not less than 0.032 in (0.0025 in minus tolerance) [0.81 mm (0.064 mm minus tolerance)]. Copper tubing 1/4 in (6.4 mm) OD shall have a nominal wall thickness of 0.030 in (0.0025 in minus tolerance) [0.76 mm (0.064 mm minus tolerance)].

7.2.4 Steel tubing shall have a nominal wall thickness of not less than 0.028 in (0.003 in minus tolerance) [0.71 mm (0.08 mm minus tolerance)] and shall have a corrosion-resistant exterior coating equivalent to that afforded by paint.

7.2.5 Hose clamps shall be of the non-adjustable type.

7.2.6 Metallic fuel-line tubing fittings shall be of the type conforming to the Standard for Cast Copper Alloy Fittings for Flared Copper Tubes, ASME B16.26, or the equivalent.

7.2.7 High-pressure injection tubing shall comply with the following:

- a) The Hydrostatic Strength Test for Nonmetallic Fuel Hose Assemblies Used on the Outlet Side of the Fuel Pump, Section 30, with a test pressure of four times rated pressure,
- b) The Tube-Fitting and Hose Connection Pull Test, Section 32, and
- c) Flexible tubing or hose shall conform with the Standard for Fuel and Oil Hoses, SAE J30.

7.2.8 Nonmetallic fuel-confining parts, including gaskets or seals, shall comply with requirements in 18.7. Glass filter bowls may be used where they are located within the framework of the generator.

7.2.9 Fuel lines shall be supported to minimize chafing and to maintain at least a 1/2 in (12.7 mm) clearance from bare exhaust components. Electrical wiring shall not be tied to fuel lines and shall be routed so that it is not capable of inadvertently contacting fuel lines.

7.2.10 Tubing other than high pressure tubing or hose shall conform with the Standard for Fuel and Oil Hoses, SAE J30.

Exception: Materials that comply with volume change and weight loss tests in 18.7 do not need to conform to SAE J30.

7.3 Corrosion resistance

7.3.1 If corrosion of a ferrous part will interfere with the proper functioning of a part, the part shall be provided with a corrosion-resistant protective coating.

7.3.2 A fuel-confining part that is constructed of drawn brass or machined from brass rod containing more than 15% zinc shall be capable of withstanding, without cracking, the 10-Day Moist Ammonia-Air Stress Cracking Test for Brass Parts Exposed to Fuel, Section 31.

7.4 Carburetors

7.4.1 The carburetor shall be located so that overflow of gasoline due to excess choking will flow to ground and not contact electrical parts and exhaust system, or collect in an engine compartment.

7.4.2 A downdraft carburetor, if mounted over an engine and having an external float bowl vent opening, shall have a vent overflow tube to direct fuel away from the engine in case of fuel overflow.

7.4.3 Deleted February 28, 2011

7.4.4 Engines shall conform with the requirements of the Intake Backfire Test, Section 29.

Exception: This test is not required for diesel fueled generator assemblies.

7.4.4 revised February 28, 2011

8 Fuel Systems – Liquefied Petroleum Gas

8.1 General

8.1.1 Where an LP-gas fuel system is provided as part of the generator system it shall include the complete fuel system installed at the factory, except as indicated in 8.1.2.

8.1.2 Products equipped to use a removable fuel container may be shipped without the fuel container if a nameplate that identifies the correct fuel-container assembly to be used is attached adjacent to the container-mounting hardware.

8.1.3 Nonductile (regular gray iron) cast iron shall not be used for LP-gas confining parts.

8.1.4 An external body or fitting provided with tapered threads shall be threaded in accordance with the Standard for General Purpose Pipe Threads (Inch), ASME B1.20.1.

8.1.5 Vaporizers, regulators, valves, filters, and other fuel-system components subject to container pressure shall be of a type designed for use with LP-gas at a working pressure not less than 250 psi (1.72 MPa).

8.1.6 Valves and connections on containers shall be protected or located within the profile of the generator to minimize the possibility of damage. Valves shall be protected to minimize the possibility of damage due to overturning, or other accidents.

8.1.7 All fuel-system components shall be fastened securely to minimize the possibility of loosening due to vibration.

8.2 Containers

8.2.1 A fuel container shall be a pressure vessel constructed, tested, and marked in accordance with:

- a) The ASME Unfired Pressure Vessel Code, or
- b) The U.S. Department of Transportation (DOT) Specifications for LP-Gas Containers.

8.2.2 A fuel container may be fixed to or removable from the generator unit.

8.2.3 An ASME fuel container shall have a designed working pressure of 312, 343, or 375 psi (2.15, 2.36, or 2.59 MPa). It shall be marked with the ASME "U" symbol and the design working pressure.

8.2.4 A DOT fuel container shall be constructed, tested, and marked for a minimum service pressure of 240 psi (1.65 MPa). It shall bear the marking DOT-4B240, DOT-4BA240, DOT-4BW240, or DOT-4E240.

8.2.5 A fuel container shall be so located as to minimize the possibility of damage to the container or its fittings. The fittings of a removable container shall be protected to minimize the possibility of damage during removal, filling, and replacement.

8.2.6 A fuel container shall be secured in place so as to meet the requirements of the LP-Gas Container Load Tests, Section 34.

8.2.7 A removable fuel container shall be designed to engage a substantial positioning pin or an equivalent means for proper positioning of the container when reinstalled so that the relief valve is not directed toward operator controls or hot engine parts.

8.2.8 If a removable fuel container is used, means shall be provided in the fuel system to minimize the escape of fuel when the container is changed.

8.2.9 The use of a quick-closing coupling (a type closing in both directions when uncoupled) in the fuel line shall be considered as complying with the requirements of 8.2.8.

8.2.10 Welding, if necessary, shall be made only on saddle plates, lugs, or brackets originally attached to the container by the manufacturer.

8.2.11 A fuel container from which vapor only is to be withdrawn shall be installed and equipped with connections arranged to minimize the accidental withdrawal of liquid.

8.2.12 A fuel container shall be shielded, if necessary, against direct heat radiation from the engine and exhaust system. See Table 19.2.

8.2.13 A removable-type container shall have the protection means for the fittings permanently attached to the container.

8.2.14 An excess-flow and a back-pressure check valve, if required, shall be located inside the container.

8.2.15 The filling connection shall be fitted with a double back-pressure check valve, or a hand-operated shutoff valve and a back-pressure check valve.

8.2.16 A removable container may employ a hand-operated shutoff valve with an internal excess-flow check valve.

8.2.17 An accessible hand operated shutoff valve shall be provided on the container for each liquid or vapor fuel supply line.

8.2.18 An automatic excess flow check valve shall be provided in each container connection having an opening for the flow of gas in excess of a No. 54 drill size, 0.055 in (1.40 mm); except those connections for filling and safety relief valves.

8.3 Gauges

8.3.1 A variable liquid-level gauge (such as a slip-tube or rotary type) which requires venting of fuel to the atmosphere shall not be used on a fuel container.

8.3.2 A fixed-tube gauge shall be employed on the fuel container, except as indicated in 8.3.3.

8.3.3 A removable container filled by weight only is not required to employ a fixed-tube gauge.

8.3.4 The length of a fixed-tube shall be such that, when the lower end touches the surface of the liquid in the container, the volume of the contents will not exceed 80% of the total container volume. This condition shall be met on a removable container regardless of whether the container is being filled in the horizontal or vertical position.

8.3.5 ASME containers shall have, permanently attached to the container, adjacent to the fixed liquid level gauge, or on the container nameplate, markings showing the percentage full that is indicated by the gauge.

8.3.6 Each container, whether constructed to ASME or DOT specifications, equipped with a fixed liquid level gauge for which the tube is not welded in place shall be permanently marked adjacent to such gauge or on the container nameplate as follows:

a) Containers designed to be filled in one position shall be marked with the letters "DT" followed by the vertical distance [to the nearest tenth inch (2.5 mm)] measured from the top center of the container boss or coupling into which the gauge is installed to the maximum permitted filling level. The exterior of the removable dip tube gauging device shall bear a corresponding "DT" marking.

b) Portable universal type containers that may be filled in either vertical or horizontal position shall be marked as follows:

- 1) For Vertical Filling – With the letters “VDT” followed by the vertical distance (to the nearest tenth inch), measured from the top center of the container boss or coupling into which the gauge is installed to the maximum permitted filling level.
- 2) For Horizontal Filling – With the letters “HDT” followed by the vertical distance (to the nearest tenth inch), measured from the center line of the container boss or coupling opening into which the gauge is installed to the inside top of the container when in the horizontal position.

8.3.7 A nonventing, indicating-type liquid-level gauge (such as magnetic type) shall be provided on each container.

8.4 Fuel lines and fittings

8.4.1 All piping from a fuel container to the first-stage regulator shall be iron, steel (black or galvanized), brass, or copper pipe; seamless copper or steel tubing; flexible LP-gas hose; or other equivalent piping means.

8.4.2 Steel tubing shall have a minimum wall thickness of 0.049 in (1.24 mm) and shall have a corrosion-resistant exterior coating. Paint is considered to be an acceptable corrosion-resistant coating. Copper tubing shall have a minimum wall thickness of 0.032 in (0.81 mm) and shall be annealed. Aluminum piping or tubing shall not be used.

8.4.3 A length of flexible hose of a type designated for use with LP-gas shall be employed between a removable container and any fixed fuel-system parts, and between any high-pressure parts on the frame and parts which are mounted on the engine.

8.4.4 Tubing fittings shall be of a type designated for use with LP-gas.

8.4.5 Hose fittings shall be of a type for use with the LP-gas hose employed.

8.4.6 Cast fittings shall not be employed for either piping or tubing.

8.4.7 Fuel lines shall be supported to minimize chafing and to maintain at least a 1/2 in (12.7 mm) clearance from bare exhaust components. Electrical wiring shall not be tied to fuel lines and shall be routed so that it is not capable of inadvertently contacting fuel lines.

8.4.8 Flexible hose passing through sheet metal shall be installed to minimize hose abrasion, such as by use of clamps and grommets.

8.4.9 All pipe threaded fuel system fittings, including container fittings, shall be assembled using a pipe joint sealing compound designed for use with LP-gas. All fuel-system connections, including the container with associated valves and fittings, shall be tested for leaks with a soap and water solution or equivalent while the system is under LP-gas pressure of not less than 90 psi (621 kPa).

8.4.10 The fuel container and associated valves and fittings may be tested separately using air pressure of not less than 90 psi (621 kPa).

8.5 Vaporizers

8.5.1 Each vaporizer shall have a valve or plug located at or near the lowest portion of the section occupied by the water or other heating medium which will permit substantially complete draining of the vaporizer.

Exception: When the vaporizer heating fluid system drain is located at the lowest point that it is able to serve as a drain of the entire engine cooling system or engine oil system, a separate vaporizer drain valve or plug is not required.

8.5.1 revised December 4, 2009

8.5.2 Each vaporizer shall be marked with the design working pressure in pounds per square inch gauge (kPa) and with the water capacity of the fuel-containing portion in pounds (kg).

8.5.3 Engine exhaust gases shall not be used as a direct means of heat supply for the vaporization of fuel unless the materials used for parts of the vaporizer in contact with the exhaust gases are resistant to the corrosive action of exhaust gases and the vaporizer system is designed to prevent excessive pressure.

8.5.4 Vaporizers shall not be equipped with fusible plugs.

8.6 Safety control and relief devices

8.6.1 A spring loaded internal-type safety relief valve with proper start-to-discharge setting and flow capacity, as detailed in 8.6.2 – 8.6.7, shall be provided on the fuel container.

8.6.2 A safety relief valve to be used on an ASME container shall be set, sealed, and marked with a start-to-discharge pressure not higher than the marked design working pressure of the container, and not less than 88% of the marked design working pressure of the container.

8.6.3 A safety relief valve on an ASME container shall be marked with its discharge capacity in cubic feet (cubic meters) per minute of air in accordance with Table 8.1 which relates the minimum required flow capacity to the outside surface area of the container.

Table 8.1
Safety relief valve capacity

Container surface area		Minimum flow rate of air	
ft ²	m ²	CFM	m ³ /min
20 or less	1.86	626	17.7
25	2.32	751	21.3
30	2.79	872	24.7
35	3.25	990	28.0
40	3.72	1100	31.1

8.6.4 A safety relief valve on a DOT container shall be set for a start-to-discharge pressure of 375 psi (2.59 MPa) and shall comply with the DOT regulations.

8.6.5 A safety relief valve shall have direct communication with the vapor space of the container.

8.6.6 The outlet from a container safety relief device shall discharge to the outside of enclosed spaces and as far as practicable from possible sources of ignition. A loose-fitting rain cap shall be provided on the end of discharge outlet piping. The cap shall be attached to prevent its being lost.

8.6.7 If a discharge line from the container safety relief device is used, it shall be of metal (other than aluminum), sized and located so as not to restrict the required flow of gas from the safety relief device. Such a discharge line shall be so constructed and installed as to minimize the possibility of its being dislodged by the discharge from the safety relief device and shall be directed upward within 45 degrees of the vertical.

8.6.8 An automatic shutoff valve shall be provided in the fuel system at some point ahead of the inlet of the first-stage regulator, designed to prevent flow of fuel when the ignition is off and the engine not running or if the engine should stop. This device shall permit the back flow of fuel from the vaporizer in the event of a pressure build-up in the vaporizer. The device shall be of a type designed for use with LP-gas at a working pressure of not less than 250 psig (1.72 MPa).

8.6.9 An automatic switch, such as an oil-pressure switch or vacuum switch, provided to control the automatic shutoff valve shall be rated for the load controlled and shall be of a type which is designed for the intended use.

8.6.10 A hydrostatic relief valve shall be installed between the container shutoff valve and the automatic shutoff valve of a liquid withdrawal system. The relief valve shall be set to discharge at not higher than 500 psig (3.45 MPa) nor lower than 400 psig (2.76 MPa). The valve discharge shall be arranged to vent outside of the system enclosure.

8.6.11 Automatic pressure-reducing equipment incorporating an automatic shutoff means to prevent the passage of fuel when the engine is not running shall be employed.

8.7 Nonmetallic parts

8.7.1 A synthetic-rubber part in contact with LP-gas shall not show excessive volume change or loss of weight, when considered on the basis of its intended function, following immersion for 70 hours in hexane.

8.7.2 A change in volume of not more than 25% swelling or 1% shrinkage, and a weight loss (extraction) of not more than 10% is considered as indicating compliance with 8.7.1.

8.7.3 A part made of synthetic rubber which may be affected by aging shall not crack or show visible evidence of deterioration following exposure in an air oven for 70 hours at $100 \pm 2^\circ\text{C}$ ($212 \pm 3.6^\circ\text{F}$).

8.8 Corrosion resistance

8.8.1 If corrosion of a ferrous part will interfere with the proper function of a part, the part shall be provided with a corrosion-resistant protective coating.

8.8.2 A part made of drawn brass or machined from brass rod containing more than 15% zinc shall be capable of withstanding, without cracking, 10-Day Moist Ammonia-Air Stress Cracking Test for Brass Parts Exposed to Fuel, Section 31.

9 Exhaust System

9.1 Engine-generators shall have complete exhaust systems and guarding in accordance with the requirements of this standard. Mufflers shall be qualified by the U.S. Department of Agriculture as a spark arrester for internal combustion engines per USDA-Forest Service Standard 5100-1C or a separately-qualified component add-on arrester shall be factory-installed in the exhaust system or shall be shipped with the unit as an accessory with instructions and precaution for the user to install the add-on arrester(s). The instruction manual (Section 51) shall indicate spark arrester maintenance and replacement requirements.

9.2 The muffler shall be located so that it complies with 19.7.

9.3 Exhaust components of ferrous sheet, pipe, or tubing materials shall be constructed to assure strength, rigidity, and durability and shall also be protected against corrosion by painting, galvanizing, plating, or by other equivalent means. Compliance is checked by visual inspection and tested in accordance with Impact Tests, Section 20, Mechanical Load Test, Section 23, and the Muffler After Fire Test, Section 27, for engines.

ELECTRICAL SYSTEM

10 Enclosure

10.1 General

10.1.1 A generator shall be so formed and assembled that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire or accident due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

10.1.2 For unreinforced, flat surfaces, cast metal shall be not less than 1/8 in (3.2 mm) thick, except that malleable iron may be not less than 3/32 in (2.4 mm) and die-cast metal may be not less than 5/64 in (2.0 mm) thick. See 10.1.7. Corresponding thicknesses not less than 3/32, 1/16, and 3/64 in (2.4, 1.6, and 1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size or both of the surface is such that adequate mechanical strength is provided. Also see 10.1.3.

10.1.3 An enclosure of sheet metal is judged with respect to its size, shape, thickness of metal, and its suitability considering its intended function. The use of sheet steel less than 0.026 in (0.66 mm) thick if uncoated or less than 0.029 in (0.74 mm) thick if galvanized or of nonferrous sheet metal having an average thickness less than 0.036 in (0.91 mm) is not allowed, except for relatively small areas or for surfaces that are curved or otherwise reinforced.

10.1.4 A polymeric enclosure or polymeric part of an enclosure shall comply with the requirements for "all other portable equipment" in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

10.1.5 Electrical parts of the generator shall be located or enclosed so as to provide protection against accidental contact with uninsulated live parts having peak voltages above 21.2 V. Insulated brush caps do not require an additional enclosure.

10.1.6 The parts of enclosures and guards which may be removed by the user without the use of tools shall be removed before determination of compliance with the requirements of 10.1.5.

10.1.7 Openings in the enclosure of a generator shall conform to the requirements given in 6.1.1.4.

10.2 Batteries

10.2.1 Batteries provided as part of the engine-generator assembly shall be:

- a) Secured in position,
- b) Positioned or shielded to prevent accidental short circuit from conductive materials, tools, or parts of the engine-generator,
- c) Accessible for replacement,
- d) Readily accessible for maintenance, and
- e) Installed at least 3 in (76.2 mm) away from arc-producing devices (e.g., switches and relays) unless the battery is a sealed non-maintenance type.

10.2.2 Battery compartments provided without an installed battery or provided separately as an accessory shall comply with 10.2.1 when the intended battery is installed.

10.2.3 The battery supply circuit shall be provided with overcurrent protection suitable for the current and voltage involved. The protective device shall be located between the battery and any component which may fail short-circuited such as capacitors, solid-state devices, or the like.

10.2.4 The interior of a metal compartment housing a lead-acid battery shall be protected against corrosion by two coats of acid resistant paint, two coats of enamel individually baked on, or the equivalent.

11 Electric Shock

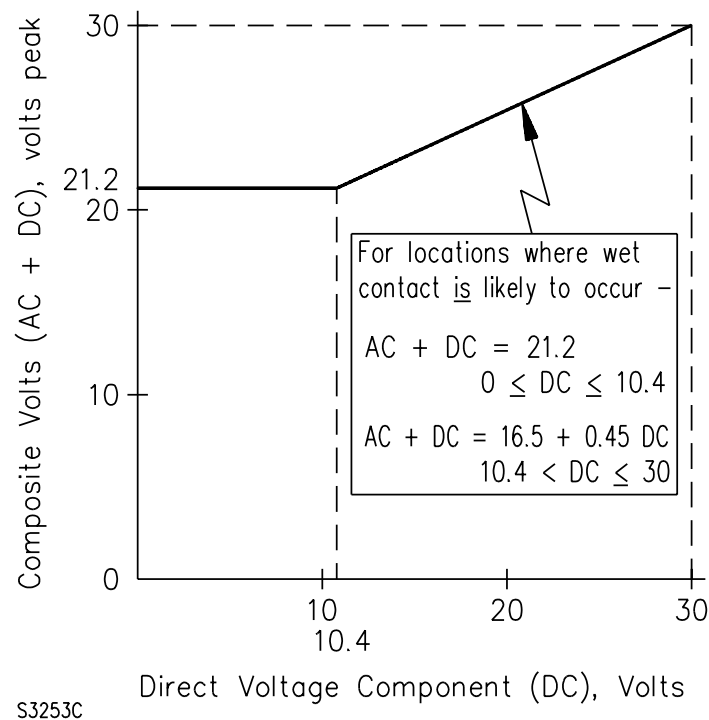
11.1 Voltage

11.1.1 A live part is not considered to be a risk of electric shock if the voltage of the part does not exceed the values specified in Table 11.1.

Table 11.1
Risk of electric shock – maximum acceptable voltage

Voltage type	Voltage
1. Sinusoidal, AC	15 V, rms
2. Nonsinusoidal, AC	21.2 V, peak
3. Pure DC	30 V
4. DC interrupted at a rate of 10 to 200 Hz	12.4 V, peak
5. Combinations of dc and sinusoidal ac at frequencies not greater than 100 Hz	See Figure 11.1

Figure 11.1
Maximum voltage



11.2 Stored energy

11.2.1 The allowable capacitance between capacitor terminals that are accessible shall satisfy the following expressions:

$$V < 367 \text{ where } 2.67 \leq C < 13.9$$

$$V < 2314 C^{-0.7} \text{ where } 13.9 \leq C < 497$$

$$V < 30 \text{ where } C \geq 497$$

In which:

C is the capacitance of the capacitor in microfarads (μF), and

V is the voltage across the capacitor in volts. V is to be measured 5 seconds after the capacitor terminals are accessible by the removal or opening of a cover, or the like. Typical calculated values appear in Table 11.2.

Table 11.2
Risk of electric shock – stored energy current

Capacitance, μF	Maximum allowable voltage across the capacitor, V
2.67 to 13.9	367
20.0	284
50.0	150
100.0	92.1
184.5	60.0
200.0	56.7
497.0 or more	30.0

12 Low Voltage Limited Energy Circuit

12.1 One or more resistors, or a regulating network used to limit the current, shall be such that the current under any condition of load including short circuit does not exceed:

- a) The voltage limits specified in Table 12.1, and
- b) 8 A for 0 – 21.2 V peak AC, or 0 – 15 V DC.

Table 12.1
Rating for fuse or circuit protector

Circuit voltage (V)	Maximum overcurrent protection (A)
0 – 21.2 (peak) 0 – 15 DC	5