
SAFETY AND PERFORMANCE OF PORTABLE GENERATORS

ANSI/PGMA G300-2015

Sponsor:



American National Standard

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They should be sent to the Portable Generator Manufacturers' Association.

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SAFETY AND PERFORMANCE OF PORTABLE GENERATORS

FOREWORD

NOTE This Foreword is included for information only and is not part of ANSI/PGMA G300-2015, *Safety and Performance of Portable Generators*.

The following standard has been developed by the Technical Committee of the Portable Generator Manufacturers' Association (PGMA) as an assistance and guide to the manufacturers, purchasers, and users of portable generators. It is intended to provide a uniform method for evaluating the safety and performance of portable generators.

PGMA approved the standard as a PGMA standard on March 18, 2015. The ANSI Board of Standards Review granted approval of the document as an American National Standard on June 1, 2015.

PGMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Portable Generator Manufacturers' Association, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851. All constructive suggestions for expansion and revision of this standard are welcome.

The existence of an American National Standard does not in any respect preclude any PGMA member or non-member from manufacturing or selling products not conforming to this standard nor is the PGMA responsible for its use.

In this standard, the following print types are used:

- Requirements: in roman type
- *Test specification: in italic type*
- Notes: in smaller roman type

Words in **bold** in the text are defined in Clause 2.

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SAFETY AND PERFORMANCE OF PORTABLE GENERATORS

1 Scope

This standard applies to 15 kW or smaller; single phase; 300 V or lower; 60 hertz; gasoline, liquefied petroleum gas (LPG) and diesel **engine** driven **portable generators** intended for multiple use and intended to be moved, though not necessarily with wheels. Permanent stationary generators, 50 hertz generators, marine generators, trailer mounted generators, generators in motor homes, generators intended to be pulled by vehicles, **engine** driven welding power sources and **portable generators** with AC output circuits that are not compatible with NEMA receptacles are not covered.

2 Definitions

Enclosure

Any surface or surrounding structure that prevents access to parts that may involve a risk of electric shock to persons.

Engine

An internal combustion device that converts fuel into mechanical power.

Guard

Any surface or surrounding structure that prevents access to parts that may involve a risk of injury to persons due to mechanical or thermal hazards.

Live part

A conductive part intended to be energized in normal use that may pose a risk of electric shock

Load

An electrical demand expressed in watts; purely resistive.

No load frequency

The measured frequency of the output **voltage** while no **load** is applied to the unit.

Portable generator

An **engine**-driven device that converts mechanical energy into electrical energy and is intended to be movable to supply temporary electrical power.

Receptacle

One or more electrical contact device(s) for the connection of an external attachment plug for the purpose of supplying power.

Rated wattage

The output power rating of a **portable generator** as defined by the manufacturer.

Tool

Any object which is not part of the **portable generator** that is used in combination with a person's hand to operate a fastening device.

Voltage (V)

Potential difference measured between two points, either AC root mean square (RMS) or DC.

3 General Construction

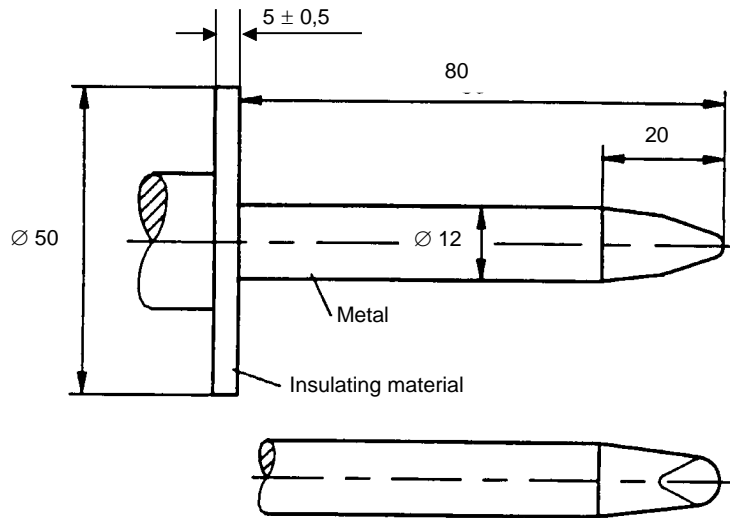
3.1 Guarding of Moving Parts

3.1.1 Guards provided to protect against hazardous moving parts shall be inherently resistant to corrosion or shall be suitably protected by appropriate means to resist corrosion in accordance with 3.5.1.

Compliance is checked by inspection.

3.1.2 Moving parts that may cause injury to persons shall be adequately guarded.

*Compliance is checked by applying Test Probe 11 of IEC 61032 (see Figure 1) with a 1 lb. maximum force through any opening in the **portable generator**, including openings in **guards** or covers. **Guards** that can be removed without the use of a **tool** are removed for this test. The probe shall not contact any moving part.*



(all dimensions in millimeters)

Figure 1 - IEC 61032 Test Probe 11¹

3.2 Live Parts

3.2.1 Bare **live parts** over 30V AC or 50V DC to the frame during normal operation shall be protected by an **enclosure** that complies with 5.1 or be located to otherwise prevent contact, personal injury and/or property damage.

Compliance is checked by the requirements of 5.1 or by inspection.

3.3 Surface Temperatures

3.3.1 **Portable generators** shall be designed to reduce the risk of burns or fire.

At the conclusion of the temperature test specified in 6.2.1, surface temperatures shall not exceed the limits as specified in Table 2 or else the surface shall comply with 3.3.2.

3.3.2 Any surface with a maximum surface temperature that exceeds the limits specified in Table 2 shall be either:

- Labeled in accordance with 7.2; or
- Guarded in order to pass the test of 3.3.2.1

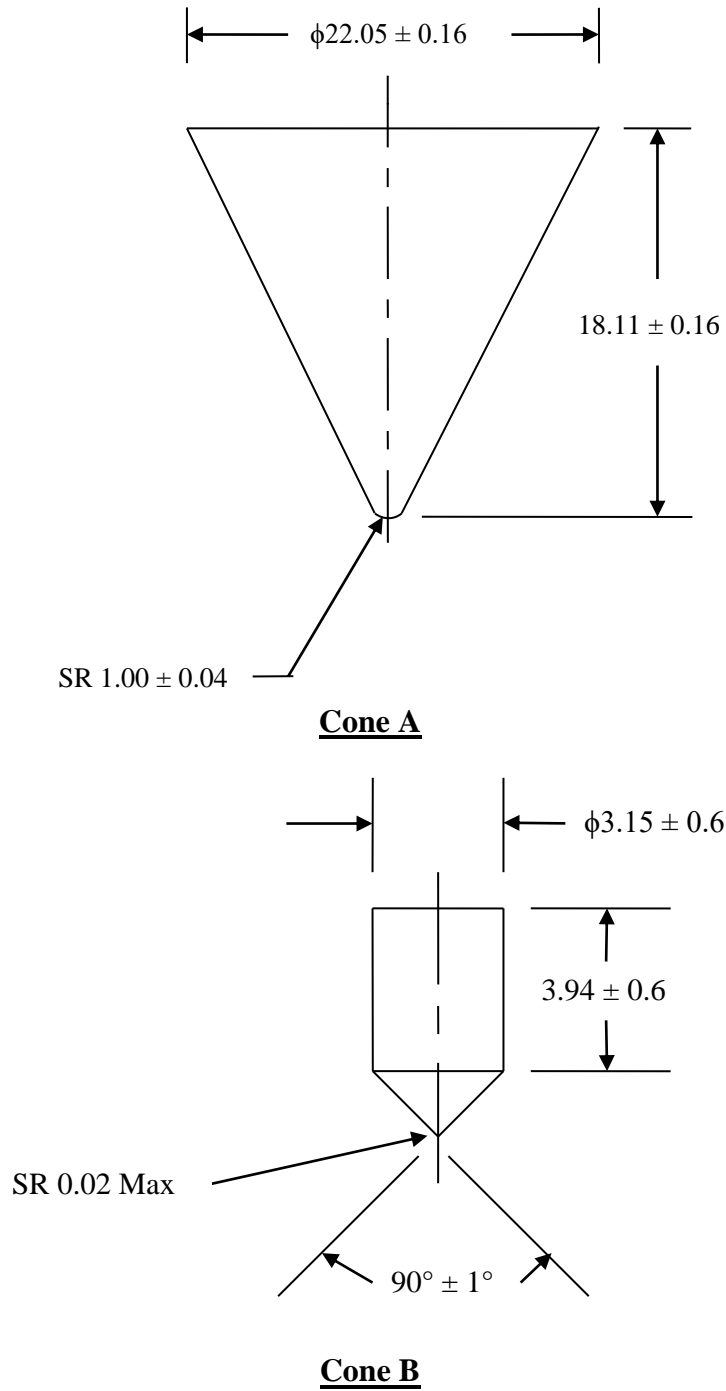
3.3.2.1 *It is not necessary to test the accessibility of hot parts while they are hot. Allow hot parts to cool before using the cone(s).*

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*All hoods and **guards** shall be in their normal operating position during this test.*

When the distance between the identified hot area and the nearest control is in excess of 100 mm (3.9 in), cone A as shown in Figure 2 shall be used. For distances less than or equal to 100 mm (3.9 in) between the identified hot area and the nearest control, cone B as shown in Figure 2 shall be used. For cone A, with the axis of the cone 90° to the horizontal and with the nose or point of the cone in a downward direction, move the cone towards the hot surface. The cone shall not be moved in an upward direction. When moving the cone, determine if contact is made with the hot surface area(s) with the spherical tip. Cone B (see Figure 2) shall be used with the axis of the cone in any direction and moved in any direction.

The spherical tip of Cone A or spherical tip or conical surface of cone B shall not contact any individual area of 10 cm² (1.55 in²) or more of the hot surface.



Cone A and Cone B drawings were reproduced from EN 12601 with permission.
All dimensions in inches.

Figure 2 - Test cones for hot parts accessibility

3.4 Sharp Edges

3.4.1 Parts that are likely to be touched during normal operation, maintenance or transport shall be free from sharp edges, burrs, flashes and the like.

Compliance is checked by inspection or in case of doubt, the test described in UL 1439.

3.5 Corrosion Resistance

3.5.1 Ferrous metal parts used for the following purposes shall not create a hazard due to corrosion or shall be suitably protected by plating, painting or equivalent means to resist corrosion:

- Electrically conductive parts;
- Parts that are used as a bonding path;
- **Enclosures and guards for live parts** and moving parts, including mounting hardware;
- Exhaust system parts;
- Fuel system parts including fuel lines, fittings and tanks; and
- Mounting means for wet cell lead-acid batteries.

Compliance is checked by inspection.

3.5.2 Dissimilar metal or alloy joints or other dissimilar metal contact surfaces that promote galvanic corrosion which could cause the **portable generator** to fail to comply with this standard shall be avoided.

Compliance is checked by inspection.

3.6 Rain Test

The **portable generator** shall be capable of safe operation following the performance of a rain test.

Compliance is checked by the test of 6.2.10.

3.7 Engine Shutoff Means

Portable generators shall be equipped with a means to readily shut off the **engine**. This may be accomplished by electrical or mechanical means.

Compliance is checked by manual test.

3.8 Stability

Portable generators shall have adequate stability.

Compliance is checked by the test of 6.2.5.

4 Mechanical Construction

4.1 Engines

4.1.1 General

4.1.1.1 Start/Stop Safety

4.1.1.1.1 Manual Starting Safety

Engines shall be positioned in a manner that allows the recoil starter handle to be fully extracted/retracted without user contact with harmful surfaces or edges.

Compliance is checked by inspection.

4.1.1.1.2 Remote Start Safety

When equipped, remote start systems that employ a remote control separate from the **portable generator** shall be so designed as to prevent inadvertent starting by requiring a minimum of two separate actions for activation.

Compliance is checked by inspection.

4.1.1.1.3 Shut-Down Safety

Portable generators shall be equipped with a suitable means for unit shut-down that meets all of the following requirements:

- The shut-down mechanism shall require only one action;
- The shut-down mechanism shall override all run commands;
- A minimum of one shut-down mechanism shall be open for access at all times and shall not be positioned in such a manner that requires the removal or opening of any material (i.e. panel cover) that requires use of a **tool**; and
- All shut-down mechanisms shall be labeled or marked with an indication of their function and the required action to activate the function.

Compliance is checked by inspection.

4.1.1.2 Engine Overspeed Safety

Portable generators shall not create hazards to persons in the event of an **engine** overspeed condition.

Compliance is checked by the test of 6.2.4.

4.1.1.3 Power Output

The means of connecting to the power output of a **portable generator** shall be suitably designed to match the intended **voltage** and frequency and shall be appropriately overcurrent protected.

Receptacles shall be powered by circuits of specified output (**voltage** and frequency) and shall be limited to rated amperage via adequate overcurrent protection.

NOTE In the case of parallel operation of inverter units, additional overcurrent protection of individual **receptacles** may be required.

Compliance is checked by inspection.

4.1.1.4 Synchronous portable generators

Portable generators that use synchronous technology shall have the throttle controlled in such a manner that the output frequency is maintained between 57 and 63 Hz during normal operation. This requirement does not apply when a device reduces **engine** speed under no-**load** conditions.

Compliance is checked by measurements.

4.1.2 Exhaust System

4.1.2.1 General requirements

Portable generators shall have a complete factory installed exhaust system, including any required guarding to meet the requirements of 4.1.2.2 and 4.1.2.3.

Compliance is checked by inspection.

4.1.2.2 Exhaust system protection

Components of the exhaust system shall comply with 3.3 (Surface Temperatures) regarding exposure to hot surfaces.

Appropriate **guards** or heat shields shall be provided to prevent contact with hot exhaust parts during normal operation of the **portable generator**. **Guards** and shields shall be constructed with adequate strength and shall be protected against deterioration from corrosion in accordance with 3.5.1.

Compliance is checked by inspection and by the tests of 3.3.

4.1.2.3 A muffler spark arrester per USDA Forest Service Standard 5100-1d shall be factory installed in the exhaust system or be made available, with installation instructions, to the user.

Compliance is checked by inspection.

4.2 Fuel Systems

4.2.1 Fuel Systems – General

Fuel systems shall be so designed and constructed as to withstand the effects of normal and expected use, without leakage.

Compliance is checked by the relevant tests of ANSI/OPEI B71.10 - 2013.

4.2.2 Liquefied Petroleum Gas (LPG)

4.2.2.1 General

A shut-off valve shall be provided on the manufacturer's specified fuel container, or between the fuel container and fuel system regulator.

Provision shall be made to compensate for expansion, contraction, jarring, and vibration. This may be accomplished by flexible connections.

An automatic shutoff valve shall be provided in the fuel system at some point ahead of the inlet of the gas-air mixer, designed to prevent flow of fuel to the mixer when the ignition is off and the **engine** is not operating. Two-stage atmospheric type regulators (zero governors) shall be considered adequate as an automatic shutoff valve.

Compliance is checked by inspection.

4.2.2.2 LP Cylinder

If the **portable generator** is provided with a LP cylinder, the LP cylinder shall be a certified vapor withdrawal DOT vertical cylinder. The valve shall include a Type 1 ACME/OPD (Overflow Protection Device), in accordance with ANSI Z21.81.

A manual shutoff valve shall also be supplied with the cylinder.

Compliance is checked by inspection.

4.2.2.3 LP Cylinder Retention

This subclause only applies if a manufacturer provides a method for LP cylinder retention.

Provision shall be made to secure the LP cylinder while transporting the **portable generator** and when the unit is operating within the manufacturer's recommended operating range.

Compliance is checked by inspection.

4.2.2.4 LP Regulator

The first stage (high pressure) regulator shall be rated to withstand a minimum 250 psi input pressure. Output pressure of the second stage regulator shall be rated to be within the limits of the specific mixer used in the **engine** application.

Compliance is checked by inspection.

4.2.2.5 LP Flexible Hose, Couplings and Connectors

All components shall be rated to perform in the temperature range of -40° F to 130° F (-40° C to 54.5° C).

Components shall be listed to UL569.

Hose shall be fabricated of materials that are resistant to the action of LP-Gas in liquid and vapor phases, and oil. If wire braid is used for reinforcing the hose, it shall be of corrosion-resistant material such as stainless steel.

Compliance is checked by inspection.

4.2.2.5.1 High Pressure Flexible Hose, Couplings and Connectors

Components shall be rated for working pressure of not less than 250 psig.

Compliance is checked by inspection.

4.2.2.5.2 Low Pressure Flexible Hose, Couplings and Connectors

Components shall be rated for working pressure of at least 1 psig.

Compliance is checked by inspection.

4.3 Mechanical Strength

Portable generators shall be constructed to withstand rough handling that may be expected during transportation and use.

Compliance is checked by the tests of 6.2.6, 6.2.7 and 6.2.8.

5 Electrical Construction

5.1 Enclosures

5.1.1 General requirements

5.1.1.1 Enclosures shall be mounted in a reliable manner and shall have sufficient mechanical strength to withstand stresses that may occur during normal use and reasonably foreseeable misuse.

Compliance is checked by inspection, by the requirements of 5.1.1.2 and 5.1.1.3 and by the tests of 6.2.6 and 6.2.7.

5.1.1.2 Enclosures shall be constructed of material inherently resistant to corrosion or shall be suitably protected by appropriate means to resist corrosion in accordance with 3.5.1.

Compliance is checked by inspection.

5.1.1.3 Polymeric enclosures shall be evaluated to the requirements for "all other portable equipment" in Table 4.1 and Table 12.1 of UL 746C, or equivalent.

The manufacturer may substitute the requirements of subclause 12.4.6 of CSA C22.2 No. 100-14 for both the minimum flammability requirement of Table 4.1 and the glow-wire temperature requirement of Table 12.1 in UL 746C.

Compliance is checked by inspection and by the relevant tests of UL 746C or CSA C22.2 No. 100-14, as applicable.

5.1.1.4 Openings in **enclosures** shall not allow user access to any **live part**, bare conductor or magnet wire with a **voltage** that may exceed 30 VAC or 50 VDC during normal use.

Live parts, bare conductors and magnet wire are considered to be accessible to users if the following criteria are met:

- All **guards**, covers, shields and the like that are removable without the use of a **tool** shall be removed;
- The **live part**, bare conductor or magnet wire can be contacted using IEC 61032 Test Probe B (see Figure 3); or
- The **live part**, bare conductor or magnet wire can be contacted using IEC 61032 Test Probe 13 (see Figure 4).

Compliance is checked by inspection and by manual test.

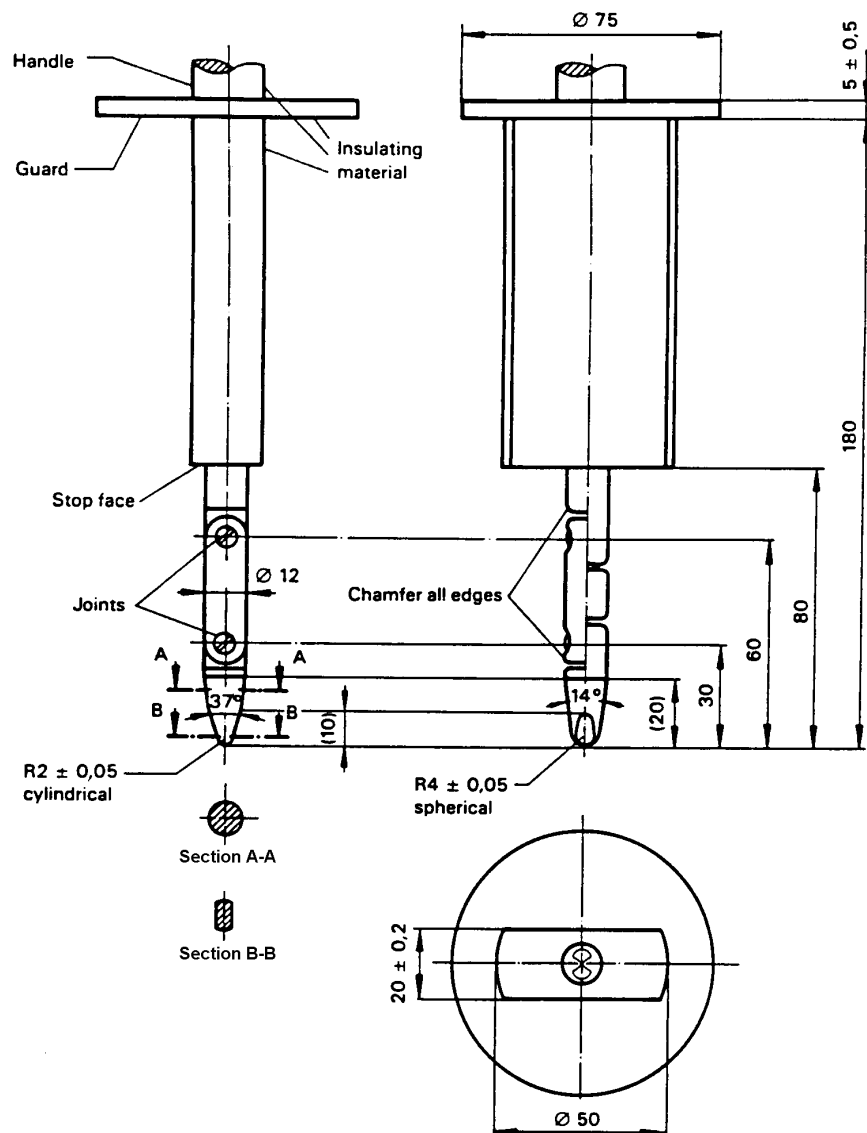
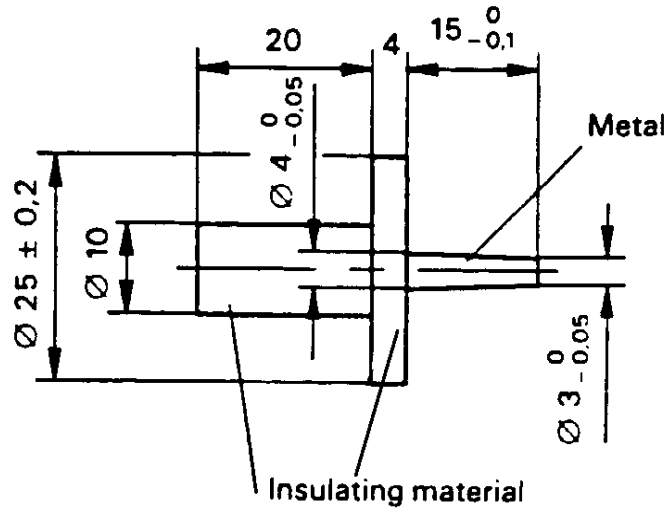


Figure 3 - IEC 61032 Test Probe B²



(all dimensions in millimeters)

Figure 4 - IEC 61032 Test Probe 13³

5.1.1.5 The mounting means for batteries shall meet the following requirements when any manufacturer's specified battery is installed:

- The battery mounting means shall reliably secure the battery in position during transportation or normal use;
- The battery mounting means shall allow access for battery replacement and maintenance;
- The battery mounting means shall be designed to prevent accidental short-circuiting of the battery terminals by **portable generator** components or other objects during normal use or reasonably foreseeable misuse: and
- The battery mounting means shall be installed a minimum of 3 inches (76 mm) from any arc-producing device, except in the case where the manufacturer specifies only sealed maintenance-free batteries.

Compliance is checked by inspection and by measurement.

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5.1.2 Receptacles

5.1.2.1 All AC **receptacle** grounding terminals shall be bonded to the **portable generator** frame.

Compliance is checked by inspection and by measurements.

5.1.2.2 **Receptacle** faces shall:

- be flush with or project from non-conductive mounting surfaces, or
- project a minimum of 0.4 mm (0.015 in.) from conductive mounting surfaces.

Compliance is checked by measurements.

5.1.2.3 **Receptacles** shall comply with ANSI/NEMA WD6, unless they are used solely for the purpose of connecting **portable generators** in parallel.

Compliance is checked by inspection.

5.1.2.4 **Receptacles** that are

- single phase; and
- rated 125 volts and either 15 or 20 amperes; and
- incorporated on a **portable generator** that includes a 125/250 volt locking-type **receptacle**

shall have ground-fault circuit interrupter protection for personnel that is integral to the **portable generator** or **receptacle**, or shall not be available for use when the 125/250 volt locking-type **receptacle** is in use.

Exception: **Portable generators** intended for use in temporary wiring installations that supply temporary power to equipment used by personnel during construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities shall:

- be provided with ground-fault circuit-interrupter protection for personnel on all 125-volt and 125/250-volt, single-phase, 15-, 20-, and 30-ampere **receptacle** outlets; and
- when used in a damp or wet location, comply with 406.9(A) and (B) of the National Electric Code.

Compliance is checked by inspection.

5.1.2.5 Ground Fault Circuit Interrupters, if provided, shall comply with UL 943.

Compliance is checked by inspection.

5.1.3 Wiring

The following subclause applies to wiring as contained within **enclosures** as well as any wiring present on a **portable generator**. For alternator wiring, subclause 5.2.2.2 takes precedence should any variation in requirements exist between the two subclauses.

Compliance is checked by the relevant portions of 5.1.3.1 and 5.2.2.2.

5.1.3.1 Conductor Size

Wiring shall be appropriately rated for a particular application with respect to temperature, **voltage**, current and environmental fluids to which it may be exposed. The conductor size shall be suitable for the maximum current required in the system and subsystems of the **portable generator**. The wiring insulation shall be suitable for the current, temperatures and environment to which it is exposed. Both shall satisfy NFPA 70 Article 310.

Alternately, wiring conductor size can be reduced in gauge size when temperature test results show that the wire temperature and device terminal rated temperatures are within the manufacturer's ratings. Temperature test to be performed as in 6.2.1.

Compliance is checked by inspection.

5.1.3.2 Wiring Connections

5.1.3.2.1 Terminals

Terminals shall be suitable for the wire type, wire material, wire diameter and the anticipated current. Where insulated terminals are used, these shall also be suitable for the anticipated temperature and **voltage**.

Terminals made of ferrous material shall be plated or otherwise protected against corrosion.

Compliance is checked by inspection.

5.1.3.2.2 Solder Connections

Terminal connections made using solder shall be mechanically secured prior to soldering, except as provided in 5.1.3.2.2.1 below. Wrapping the conductor bundle with wire and/or twisting the conductors together are considered adequate.

Compliance is checked by inspection.

5.1.3.2.2.1 Where failure of the solder joint cannot result in inadvertent contact or shorting additional mechanical securing before soldering is not required.

Note: Solder connections on printed wiring boards are covered by 5.1.4.

5.1.3.2.3 Terminal Connections

Terminals shall be prevented from turning, if such turning could result in damaged wiring or unintended electrical contact. Friction between the terminal and a fixing screw is not considered to be sufficient.

Open ended spade terminals shall be secured against inadvertent disconnection by means of upturned ends or other deliberate securing method.

Stranded wire connections must include means to prevent loose strands from inadvertently contacting conductive parts other than those intended. Crimped terminals, solder tinning or other similar constructions may be used but wrapping of bare stranded wire around a terminal screw is not allowed.

Compliance is checked by inspection.

5.1.4 Printed wiring boards

Printed wiring boards used in **portable generators** shall conform to IPC-2221B or UL 796.

Compliance is checked by inspection.

5.1.5 Overcurrent protection of portable generators

5.1.5.1 Protection of generator output AC circuits shall be provided in accordance with subclause 5.1.5.2.

5.1.5.2 Readily accessible, having a rating equal to or less than the rating of the **receptacle**, replaceable or manual reset type branch circuit protection or supplemental protection may be used in the AC output circuits of **portable generators** provided that the supplemental protector complies with the following:

- it is suitable for use in industrial equipment;
- it has an “overload must trip” classification TC0, TC1, or TC3;
- it has a “suitable for further use” classification of U3 or U1a or has a classification of C1a if provided with the required line side fuse or molded case circuit breaker;
- its short-circuit rating is equal to or greater than the available current from the **portable generator** output at rated **voltage**;

- it has an overload rating classification of OL1; and
- the 250 V single-phase output circuits are protected by multi-pole protectors.

Exception: The overcurrent function may be provided within a solid-state circuit per 5.1.5.5.

Compliance is checked by inspection.

NOTE The following definitions are provided for information:

Short-circuit current rating (SC)

The test conditions and any calibration following the short-circuit test as defined below:

C - a short circuit test was conducted with series overcurrent protection

U – a short-circuit test was conducted without series overcurrent protection

1a - the supplementary protector was permanently open after the short -circuit test. A dielectric strength test and a **voltage** withstand test were conducted.

3 - the protector has proven to be suitable for further use after the short-circuit test; recalibration, dielectric strength and **voltage** withstand tests were performed after the short-circuit testing.

Tripping current (TC)

Tripping current is coded as a percentage of the ampere rating. Codes for UL & CSA products:

TC0 - tripping current is less than 125% of ampere rating

TC1 - tripping current is between 125 and 135% of ampere rating

TC3 - tripping current is standardized at 135% and at 200% of ampere rating

Overload rating (OL)

Designates whether the protector or family of protectors has been tested for general use or motor-starting applications:

OL1 - tested at 6 times sac rating or 10 times DC rating for motor starting application.

5.1.5.3 Low **voltage** accessory output circuits, if provided, shall be appropriately protected from electrical overload and short circuits.

Compliance is checked by the following test:

*With the **engine** at the highest speed setting, apply a **load** as specified below for 5 minutes each while monitoring the output **voltage**.*

- *No-load (Circuit must operate properly during this portion of the test and no overcurrent device may open)*
- *50% of rated **load** (Circuit must operate properly during this portion of the test and no overcurrent device may open)*
- *100% of rated **load** (Circuit must operate properly during this portion of the test and no overcurrent device may open)*
- *130% of rated **load** (Circuit does not need to operate properly during this test and overcurrent device(s) may open)*
- *Short circuit (Circuit does not need to operate properly during this test and overcurrent device(s) may open)*

*During the test, no damage to the **portable generator** shall occur and the output **voltage** of the low **voltage** accessory output circuits shall not exceed the values specified in 3.2.1.*

5.1.5.4 Low **voltage** accessory output circuits that are provided with a direct current output intended to charge a non-integral battery shall be appropriately protected from reverse polarity connection of the non-integral battery.

Compliance is checked by the following test:

*Connect an appropriately rated fully charged battery to the battery charging output incorrectly (reverse polarity) and run the **portable generator** at its highest speed setting for 5 minutes. During the test, there shall be no resulting hazardous condition, including flame or molten metal. Opening of fuses during this test is acceptable. After the test, the unit shall pass the dielectric **voltage** withstand test of 6.2.9.*

5.1.5.5 Solid state overcurrent function (SSOF)

An AC output **portable generator** provided with a solid-state overcurrent function shall:

- Be capable of carrying rated circuit current without tripping;
- Trip due to an overcurrent condition; and
- Be capable of withstanding short circuits.

Compliance is checked by the following tests:

- a) *Connect the output to an adjustable resistive **load bank**.*
- b) *A **receptacle** being protected by an SSOF shall carry the rated circuit current for at least 5 min and must trip at no more than 135% of the **receptacle's** rated current.*
- c) *A short circuit test is conducted five times as specified in 6.2.2. The maximum short circuit current measured during the five tests shall be no more than the short circuit current capability of the SSOF.*
- d) *After the tests of 5.1.5.5 b) and 5.1.5.5 c) are completed, the SSOF shall withstand the dielectric **voltage** withstand test of 6.2.9.*
- e) *After the dielectric **voltage** withstand test of 5.1.5.5 d), the test of 5.1.5.5 c) is repeated.*

5.2 Alternators

5.2.1 Magnet Wire

Magnet wire shall be evaluated per ANSI/NEMA MW 1000. The maximum allowable magnet wire temperatures during operation are given in Table 3.

Compliance is checked by the temperature test of 6.2.1.

5.2.2 Construction

5.2.2.1 Portable generator output leads shall be evaluated based on the ampacity of the wire and terminals, the size and mechanical strength of the wire, and the protection required to prevent damage.

Leads not securely held in place shall be insulated with appropriate heat resistant insulated tubing or other suitable means.

Compliance is checked by inspection.

5.2.2.2 Wiring

Standard appliance and building wire, such as those specified in NFPA 70 Article 310 (Conductors for General Wiring), shall be suitable for use.

Wiring shall not be liable to damage due to stress, vibration or rubbing on sharp objects such as the end of a screw, the edge of a metal object, or other parts that could damage the wire conductor or insulation.

Wiring shall be routed to avoid hot surfaces such as muffler exhaust system parts, hot **engine** parts and moving parts.

Wiring shall not contact moving parts and shall be held securely in place.

Wiring that passes through a hole in a sheet-metal wall shall have smooth rounded surfaces or bushings to prevent damage to insulated wires.

Compliance is checked by inspection.

5.2.2.3 Insulation on conductors used as leads shall be rated and evaluated to perform in the intended application regarding **voltage**, ampacity and exposure to outside influences like sunlight, oil, fuel or grease and other conditions that the wire and insulation may be subjected.

Insulation on conductors shall be rated for the highest temperature to which it will be subjected during use.

Compliance is checked by inspection.

5.2.2.4 Uninsulated terminals shall be securely held to supporting surfaces to prevent turning or moving that would result in spacings below the values specified in 5.6.

Compliance is checked by manual test and by measurement.

5.3 Batteries

5.3.1 Batteries supplied as part of the **portable generator** shall be securely held in place to prevent damage from shifting due to tilting, dropping and vibration.

Compliance is checked by inspection.

5.3.2 Battery mechanical tie downs, if made from a conductive material such as a metal strap or bolt, shall be so designed to avoid shorting to the battery posts and terminals.

The operating environment of the battery shall comply with its marked temperature ratings and limits.

Compliance is checked by inspection and by measurement.

5.3.3 Battery terminal parts and leads shall be designed for the application and continuous output current and cranking level that it will see during operation.

Compliance is checked by inspection.

5.3.4 Battery leads shall be positioned to avoid cracking, cutting or rubbing on sharp surfaces.

Bushings, grommets, rounded edges or the like shall be used for routing battery leads through sheet metal parts.

Compliance is checked by inspection.

5.3.5 The interior of a metal compartment housing a wet cell lead-acid battery shall be protected against corrosion in accordance with 3.5.1.

Compliance is checked by inspection.

5.3.6 The mounting means for lead-acid batteries shall be provided with a means of ventilation to prevent the collection of flammable gasses.

Compliance is checked by inspection.

5.4 Power Cords

5.4.1 If supplied with the **portable generator**, cords and associated fittings shall comply with the latest edition NFPA 70, Article 400 (Flexible Cords and Cables) and be rated for outdoor use.

Compliance is checked by inspection.

5.4.2 Permanently attached wires or cords shall comply with the requirements of subclause 5.2.2.1.

Compliance is checked by inspection.

5.5 Grounding and Bonding

5.5.1 A **portable generator** shall be provided with a field grounding electrode conductor location. The field grounding means shall be such that the factory bond between the field grounding electrode conductor location and the **portable generator** frame is maintained at all times.

Compliance is checked by inspection.

5.5.2 The field grounding means shall be able to accept an 8 AWG grounding electrode conductor using a suitable connection means.

Compliance is checked by inspection.

5.5.3 All output **receptacle** ground terminals shall be bonded to the **portable generator** frame.

Compliance is checked by inspection and by the test specified in subclause 5.5.7.

5.5.4 An output conductor of the **portable generator** alternator that is bonded to the **portable generator** frame with a system bonding jumper shall meet the following requirements:

- For a two wire output, the **portable generator** alternator conductor that is bonded to the **portable generator** frame shall also be bonded to the neutral terminals of the output **receptacles**;

- For a three wire output, the **portable generator** alternator neutral conductor shall be bonded to the **portable generator** frame as well as the neutral terminals of the output **receptacles**.

Compliance is checked by inspection.

5.5.5 If a system bonding jumper described in subclause 5.5.4 is used, then it shall be sized such that its ampacity is not less than the ampacity of the largest circuit conductor used in the **portable generator**.

Compliance is checked by inspection.

5.5.6 For the case where no output conductors of the **portable generator** alternator is bonded to the **portable generator** frame in subclause 5.5.4, the following requirements are applicable:

- For a two wire output, the same **portable generator** alternator output conductor shall be bonded to the neutral terminals of the output **receptacles**.
- For a three wire output, the **portable generator** alternator neutral conductor shall be bonded to the neutral terminals of the output **receptacles**.

5.5.7 All non-current-carrying metal parts that are accessible to users and are likely to become energized due to an electrical fault shall be bonded to the **portable generator** frame. The impedance between the field grounding means and any part required to be bonded shall be less than 0.1 ohm.

Non-current-carrying metal parts are considered to be accessible to users if the following criteria are met after all **guards**, covers, shields and the like that are removable without the use of a **tool** are removed:

- The part can be contacted using IEC 61032 Test Probe B; or
- The part can be contacted using IEC 61032 Test Probe 13.

Non-current carrying metal parts are not considered likely to be energized due to an electrical fault if the following criteria are met:

- The part is insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 1/32 in (0.8 mm) thick ;
- A moisture-resistant insulating material that has a suitable insulation rating is used to insulate the non-current carrying metal parts from **live parts** ; or
- The part is completely isolated from electrical components and wiring by other bonded metal parts; or
- The part is reliably and permanently separated from wiring or electrical components by

at least 0.25 inches.

Compliance is checked by inspection and by the following test:

*Pass a minimum current of 25 amperes at 60 Hz nominal with an open circuit **voltage** less than or equal to 6 volts between the field grounding means and any part required to be bonded. The measured impedance is calculated by dividing the measured **voltage** drop by the measured current. The measured impedance shall be less than 0.1 ohm.*

5.5.8 The material used for bonding conductors shall be one of the following:

- copper;
- copper alloy;
- another suitable conductive and corrosion-resistant material.

Compliance is checked by inspection.

5.5.9 Bonding conductors shall be one of the following types:

- a wire with or without insulation;
- a bus bar; or
- a strap.

Compliance is checked by inspection.

5.5.10 Bonding conductors shall have an ampacity not less than the largest circuit conductor used in the **portable generator**.

Compliance is checked by inspection.

5.5.11 Bonding conductors shall be protected from foreseeable mechanical damage and shall be suitable for the environment in which they are used, including:

- **voltage** rating;
- temperature rating; and
- shock/vibration.

Compliance is checked by inspection.

5.5.12 The electrical connection for bonding conductors shall be accomplished by one of the following methods:

- Welding or soldering, using a material with a melting point above 850° F; or

- a fastener, such as a bolt, screw or nut, that reliably penetrates any non-conductive coating. If a fastener thread is used for the electrical connection, then at least two full threads of the fastener must be utilized for the connection.

A bonding electrical connection shall not be secured by a fastener which may need to be removed during operation or maintenance.

Compliance is checked by inspection.

5.5.13 Bonding conductors with insulation shall be marked as follows:

- the insulation color shall be green or green with one or more yellow stripes; or
- with symbol no. 5019 of IEC Publication 417 at each conductor end, except in the case described in subclause 5.6.4 where this symbol is the only means used to identify the field grounding means. In this case, the symbol no. 5019 of IEC Publication 417 with the circle omitted may be used.

Compliance is checked by inspection.

5.6 Spacings

5.6.1 The minimum creepage and clearance distances between uninsulated **live parts** of opposite polarity and between uninsulated **live parts** and non-current-carrying metal parts shall be as shown in Table 1.

Exception: For brush holders and slip rings in **portable generators**, spacings shall be:

- increased at least 50% of the relevant value in Table 1; or
- suitable barriers, collars, or the equivalent shall be provided.

Compliance is checked by measurement.

Table 1- Minimum creepage and clearance distances

Part Type	RMS Voltage	Between bare live parts of different voltage		Between bare live parts and non-current-carrying metal parts		Between bare live parts and removable metal enclosures	
		Creepage distance	Clearance distance	Creepage distance	Clearance distance	Creepage distance	Clearance distance
Installer Wiring Terminals	Less than 30	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)
	31-300	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)
Parts other than wiring terminals, including straps and bars connected to such terminals, but excluding film coated magnet wire	Less than 30	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)	0.063 in. (1.6 mm)
	31-300	0.125 in. (3.2 mm)	0.25 in. (6.3 mm)	0.125 in. (3.2 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)	0.25 in. (6.3 mm)

5.6.2 The minimum creepage and clearance distance between film coated magnet wire and non-current-carrying metal parts shall be .094 inches (2.4 mm).

Compliance is checked by measurement.

5.7 Electrical Energy Storage Components

A brushless excitation capacitor provided as a part of a **portable generator** shall either

- be of a fail safe design (e.g. P2 rating); or

- be located inside a suitably rated **enclosure** for containing flames and molten metal.

Compliance is checked by inspection.

5.8 Abnormal Operation

5.8.1 Portable generators shall be able to withstand short circuits to **receptacles** without creating hazards to persons.

Compliance is checked by the test of 6.2.2.

5.8.2 Portable generators shall be able to withstand overloading of **receptacles** without creating hazards to persons.

Compliance is checked by the test of 6.2.3.

6 Testing

6.1 General Conditions For Testing

The general test conditions in this subclause apply for all tests in this standard unless otherwise specified.

The tests are made on separate samples. However, at the manufacturer's discretion, multiple tests may be performed on a sample.

The cumulative stress resulting from successive tests on electronic circuits is to be avoided. It may be necessary to replace components or to use additional samples.

*If it is evident from the construction of a **portable generator** that a particular test is not applicable, the test is not performed.*

***Portable generators** provided with controls or switching devices are tested with these controls or devices adjusted to their most unfavorable settings, if the setting can be altered by the user. If the adjusting means of the control is accessible without the aid of a **tool**, this requirement applies whether the setting can be altered by hand or with the aid of a **tool**. If the adjusting means is not accessible without the aid of a **tool**, and if the setting is not intended to be altered by the user, this requirement does not apply. Adequate sealing is regarded as preventing alteration of the setting by the user.*

The tests are made at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$ ($(68 \pm 9) ^\circ\text{F}$).

All electrical measurements shall be made with a maximum measurement error of 5 %.

6.2 Safety Tests

6.2.1 Temperature Test

6.2.1.1 *The portable generator shall be operated at nameplate **rated wattage** (+0/-10%) until all temperatures are stabilized. The unit is considered to be at temperature stabilization when the **engine** oil temperature varies by less than 2°C (4°F) over 3 consecutive readings taken 15 minutes apart. For **portable generators** fitted with any auxiliary windings, the testing shall be done with the maximum load applied to the auxiliary windings.*

*During the test, the **portable generator**:*

- **voltage** shall be within 10% of the nameplate rating;*
- frequency shall be within 5% of the nameplate rating;*
- shall remain in fully operational capability with no damage;*
- surface temperatures shall not exceed the temperature limits as specified in Table 2;*
- insulation systems shall not exceed the temperature limits as specified in Table 3;*
- component temperatures shall not exceed their individual ratings.*

*The test may be run at any ambient temperature between 10° C and 40° C (50° F and 104° F). **Engine** exhaust shall be directed in order to minimize recirculation into the **engine** or alternator air inlets. For tests run outdoors, the test unit shall not be exposed to direct sunlight and the wind speed shall not exceed 6.7 miles/hr (3 m/sec). Temperatures shall be measured by use of thermocouples mounted to the exposed surfaces. For Coils and Windings, the temperature during operation may be determined by comparing the hot resistance to the cold resistance and calculated per the following formula:*

$$T_{Hot} = (R_{Hot} - R_{Cold}) / R_{Cold} * (K + T_{Cold}) - (T_{AmbientHot} - T_{Cold}) + T_{Rated}$$

Where:

*T_{Hot} = Temperature of winding in degrees C at end of test corrected to the rated ambient temperature of the **portable generator**.*

T_{Cold} = Temperature of winding when measuring R_{Cold}.

*T_{Rated} = Rated temperature of the **portable generator**.*

R_{Hot} = Resistance of winding in ohms at end of test at ambient of T_{Hot}, in accordance with IEC 60034-1 subclause 8.6.2.3.

R_{Cold} = Resistance of winding in ohms at beginning of test at ambient of T_{Cold}.

K = Coefficient of resistance change to temperature. K = 234.5 for Copper wire and 225.0 for electrical conductor grade aluminum wire.

T_{AmbientHot} = Ambient temperature at the end of the test.

Table 2 - Surface Temperatures

Maximum surface temperature corrected to a 20° C ambient				
Location	Component material			
	Metal		Nonmetal	
	Degrees C	Degrees F	Degrees C	Degrees F
A. Any component that is intended to be held by hand during lifting or transporting.	50	122	70	158
B. Components intended to be contacted during operation, but do not involve lifting or transporting.	55	131	80	176
C. Outer contour of the frame (with the exception of those specified in A above) and other surfaces that are not within the contour of a portable generator frame/housing or for portable generators without any protective frame.	90	194	95	203

Table 3 - Maximum acceptable temperature limits for insulation systems (corrected to the rated ambient temperature of the portable generator)

Materials and component parts	Degrees	Degrees
	C	F
1. Class A:		
Thermocouple method	115	239
Resistance method	125	257
2. Class B:		
Thermocouple method	135	275
Resistance method	145	293
3. Class E:		
Thermocouple method	125	257
Resistance method	135	275
4. Class F:		
Thermocouple method	160	320
Resistance method	170	338
5. Class H:		
Thermocouple method	180	356
Resistance method	190	374

6.2.1.2 Any surface larger than 10 cm² (1.5 in²) that operates above the temperature limits in item C of Table 2 shall be marked in accordance with 3.3.2.

Compliance is checked by inspection.

6.2.2 Short Circuit Test

*With the **portable generator** operating in a **no-load** condition, each **receptacle** is individually shorted between*

- all ungrounded conductors, and*
- between each ungrounded conductor and the grounded conductor.*

The short is maintained until

- an overcurrent protective device activates; or*
- the **portable generator** output is reduced to no greater than the rating of the overcurrent protective device; or*
- all temperatures are stabilized as specified in 6.3.2.4.*

*During the test, the **portable generator** shall not emit flame or molten metal and shall not create a risk of fire or electric shock.*

*After the test, the **portable generator** shall pass the dielectric **voltage** withstand test of 6.2.9, and any GFCI device shall remain functional as verified by the correct operation of the "Test" and "Reset" functions on the GFCI device.*

6.2.3 Overload Test

*The **portable generator** is operated at rated **load** until thermal stabilization is reached. The **load** is then increased to*

- 110% of rated **load**, or*
- maximum available power if protective devices or **engine** power do not allow the unit to operate at 110% of rated **load**.*

*The **portable generator** is then operated until thermal stabilization is once again reached, the output circuit breaker trips, or the **engine** shuts down.*

*During the test, the **portable generator** shall not emit flame or molten metal and shall not create a risk of fire or electric shock.*

*After the test, the **portable generator** shall pass the dielectric **voltage** withstand test of 6.2.9.*

6.2.4 Overspeed Test

The **portable generator** is operated with the throttle plate at the wide open (with the governor, if any, overridden) and with no electrical **load** for a duration of 1 minute.

If a **portable generator** is equipped with a control that stops the **engine** in case of overspeed, then the test duration shall be for 1 minute or until the **engine** is stopped, whichever is less.

During the test, there shall be no evidence of fire or ejected materials that could result in personal injury.

NOTE This test should be carried out in an area with no personnel exposed to potentially ejected materials or fire from the unit.

6.2.5 Mechanical Stability Test

The **portable generator** is filled with an amount of fuel and fitted with any manufacturer supplied accessories (including batteries) that results in the most unfavorable condition. The **portable generator** is not running during this test. The **portable generator** is then rotated on a surface tilted 15 degrees from the horizontal in all possible orientations. If equipped with wheels, the wheels are prevented from rolling. If the wheels are intended to be removable, then the test shall be performed twice, with the wheels assembled and then removed from the **portable generator**. The **portable generator** shall not overturn as a result of this test.

6.2.6 Drop Test

The **portable generator** shall be dropped once from its usual carrying/transporting position through a height of 8 inches (20 cm) to strike a flat concrete surface.

After the test, the unit shall exhibit no damage which would impair mechanical or electric safety and shall operate normally.

6.2.7 Impact Test

With the **portable generator** in a non-running condition, any surface of the guard for moving parts and the enclosure for **live parts** that can be exposed to an impact during normal operation or storage and whose failure could result in an unsafe condition is subjected to a single impact of 5 ft-lbs (6.78 J) produced by dropping a steel sphere 2 inches (51 mm) in diameter and weighing 1.18 lbs (0.54 kg) from a height of 51 inches (1300 mm). The **portable generator** may be rotated as required or the steel sphere may be suspended by a cord and is allowed to fall from a rest position as a pendulum from a 51 inch (1300 mm) vertical distance in order to facilitate impacting surfaces other than those on the top of the unit.

After the test, the **portable generator** shall

- meet the spacing requirements of 5.6;

- have no hazardous **live parts** that are accessible to users in accordance with 5.1.1.4; and
- have no hazardous moving parts that are accessible to users in accordance with 3.1.2.

6.2.8 Lifting Test

6.2.8.1 A static force equal to two times the dry weight of the **portable generator** is applied uniformly for one minute to the lifting means intended for overhead lifting (if provided), while maintaining the unit in an approximately level condition.

After the test, the **portable generator** shall meet the criteria set forth in 6.2.8.3.

6.2.8.2 A static force equal to two times the force experienced by handle(s) (if provided) intended to be used during transport on a level surface or lifting by hand is applied uniformly for one minute over a 3 inch width where the handle(s) would normally be grasped. If there are two or more handles provided, the force is applied to each handle independently. The force is applied in the most unfavorable direction that would be encountered during transport.

After the test, the **portable generator** shall meet the criteria set forth in 6.2.8.3.

6.2.8.3 After the tests of 6.2.8.1 and 6.2.8.2, the **portable generator** shall be inspected for the following conditions:

- The lifting means or handles did not break or be permanently distorted beyond use.
- Electrical clearances comply with 5.6.
- There is no temporary contact between **live parts** and grounded metal parts.
- Compliance with 5.1.1.4.
- Compliance with 3.1.2.
- There is no potential leakage of fuel.

6.2.9 Dielectric Voltage Withstand Test

This test is to verify the integrity of all electrical insulation associated with components that are subjected to hazardous **voltage** (as defined in 3.2.1) during normal operation.

Prior to the test, any bond from neutral to ground shall be removed. Printed-wiring assemblies and other electronic-circuit components that may be damaged by application of the test potential or that may short-circuit the test potential shall be removed, disconnected, or otherwise rendered inoperative before the dielectric **voltage** withstand tests are made. A representative subassembly instead of an entire unit may be used for the test. Semiconductor devices in the unit may be individually shunted before the test in order to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

The test **voltage** shall be 60 Hz with a value of either 1) or 2) below:

1) *Two times the rated voltage plus 1000 V between:*

- a) *Non-current carrying metal parts and **live parts** operating above 50 V, and*
- b) ***Live parts** operating above 50 V and other **live parts***

2) *500 V between non-current carrying metal parts and **live parts** operating at 50V or less.*

*A 500 VA or larger transformer, or equivalent, shall be used for testing. The test **voltage** shall be increased as quickly as possible, consistent with accurate reading of the voltmeter. The specified test voltage is maintained for 1 minute.*

During the test, there shall be no insulation breakdown.

6.2.10 Rain Test

The spraying equipment, procedure, and duration for this test are those specified by IEC 60529 Degrees of Protection Provided by Enclosures (2001 Edition), subclause 14.2.4 using IPX3, but subject to the following conditions:

- *Spraying the **portable generator** shall be conducted with the **engine** in the off position; and*
- *After completion of the water spray test, wipe off any drops of water remaining on the outside of the **portable generator** and run the **engine** for 15 minutes at no-load.*

*Immediately after shutting off the **engine**, the **portable generator** shall pass the dielectric **voltage** withstand test of 6.2.9.*

*Immediately following the dielectric **voltage** withstand test, perform a GFCI (if equipped) and over-current protector operation test. All GFCI's (if equipped) and over-current protectors shall operate normally.*

6.3 Performance Tests

6.3.1 General

The performance tests of 6.3 are not regarded as safety requirements for **portable generators**. Instead, they are intended to provide a uniform method for evaluating the performance of **portable generators**.

6.3.2 Output Power Rating

6.3.2.1 Definitions

6.3.2.1.1 Power Correction Factor

The power correction factor used for the Output Power Test shall be the same as defined in SAE J1349.

6.3.2.1.1.1 Symbols for Power Correction Factor

The symbols used for the Output Power Test are described below:

D: **Engine** displacement, L

F: Fuel flow, g/s

N: **Engine** speed, min^{-1}

Pa_{do} : Dry air pressure (absolute) observed, kPa

Q: Fuel delivery, mg/L cycle

SG_o : Fuel density at 15 °C, kg/L

t_o : Inlet air supply temperature observed, °C

V_o : Fuel viscosity at 40 °C observed, mm^2/s

6.3.2.1.1.2 Reference atmospheric conditions for Power Correction Factor

The reference atmospheric conditions are provided in Table 4 below:

Table 4 - Reference atmospheric conditions

	Standard condition	Test range limits
Inlet air pressure (absolute)	100 kPa	-
Dry air pressure (absolute)	99 kPa	90 kPa – 105 kPa
Inlet air supply temperature	25 °C	15 °C – 35°C

6.3.2.1.1.3 Power Correction Factor for Spark ignition **engines**

Mechanical efficiency of the **engine** is assumed to be 85% as allowed by SAE J1349 Mar2008.

$$\text{Power Correction Factor} = \left[1.176 \times \left(\frac{99}{Pa_{do}} \right) \times \left(\frac{t_o + 273}{298} \right)^{0.5} - 0.176 \right]$$

6.3.2.1.1.4 Power Correction Factor for Compression ignition **engines**

The following calculation applies to four stroke naturally aspirated **engines** with pump-line-nozzle fuel injection systems. For pressure charged air systems, unit injectors, common rail fuel systems or two stroke **engines** refer to SAE J1349.

$$\text{Power Correction Factor} = \left[\left(\frac{99}{Pa_{do}} \right) \times \left(\frac{t_o + 273}{298} \right)^{0.7} \right]^{FM} \times \left[1 + 0.70 \left(\frac{0.850 - SG_o}{SG_o} \right) \right] \times \left(\frac{1 + 0.15/V_o}{1.0577} \right)$$

The value of the **engine** factor FM is determined from the following table:

	FM
Q < 37.2	0.2
37.2 > Q < 65	0.036 x Q - 1.14
65 > Q	1.2

where:

$$Q = 120,000 \times F / (D \times N)$$

Notes:

- (1) This equation assumes that friction power is not measured. Mechanical efficiency is assumed to be 85% as allowed by SAE J1349.
- (2) For detail explanation of test conditions and procedures, see SAE J1349.

6.3.2.2 Documentation

The following information shall be recorded for each model tested:

- Name and company of individual conducting test
- Date of test
- Name of product OEM
- Model number/name/type
- **Rated wattage** (W)
- **Rated voltage**
- **Engine** manufacturer/model

6.3.2.3 Test Equipment

6.3.2.3.1 Calibration

- Test equipment identified in 6.3.2.3.2 shall be calibrated according to measuring device manufacturer specifications and shall be traceable to National Institute of Standards and Technology (NIST) methods or any equivalent national metrology institute. The resistive elements in the **load** bank need not be calibrated.
- The last date of calibration shall be clearly marked on each measuring device

6.3.2.3.2 Test Equipment Specifications

The manufacturer name and model number for all test equipment (measuring devices) shall be recorded. The following test equipment shall be used:

- Voltmeter capable of measuring true RMS **voltage** within at least +/- 1.5% of actual
- Wattmeter capable of measuring true RMS wattage within at least +/- 3% of actual
- Ammeter capable of measuring true RMS current within at least +/- 2.5% of actual
- Frequency sensor capable of measuring within at least +/- 1% of actual
- **Load** bank which applies a purely resistive **load**
- Temperature meter +/- 2°C (+/- 4°F) of actual. For temperature measurements that employ a thermocouple, a total tolerance of +/- 4.5° C (+/- 8° F) is allowed.
- Barometer capable of measuring within at least +/- 1% of actual
- Humidity meter +/- 5% of actual (wet bulb/dry bulb optional)

6.3.2.4 Test Procedure

- *Prepare unit(s) for test*
 - *Unit may be broken in by running under varying **load** conditions for a period as recommended by the **engine** manufacturer, but not to exceed 12 hours*
 - ***Engine** oil shall be as recommended by manufacturer and shall be changed after break in and before conducting tests*
- *Unit shall be tested in an open area which provides at least 1 meter of clearance on all 5 sides and a constant supply of fresh air*
- *Ambient air temperature shall be 15-35°C (59-95 °F), measured 300 mm (12 inches) from **engine** cooling air intake*
- *The **voltage** shall be within 10% of the nameplate rated **voltage** and the frequency shall be within 5% of the nameplate rated frequency for all **loads** from no-**load** to maximum wattage*
- *The **portable generator** shall be prepared and started in accordance with the operating instructions. Start the unit and measure the **voltage** and frequency at no-**load**. If the **voltage** or frequency is out of tolerance a minimum adjustment shall be made to the unit to bring it into tolerance. For a mechanical governor system, the **no-load frequency** should be adjusted to be between 62.5 and 63 Hertz*
- ***Load** is to be applied to the unit while monitoring the **voltage** and frequency. **Load** should be increased to the maximum available Observed Wattage output without causing the **voltage** or frequency to fall out of tolerance. When the maximum wattage is reached, the unit should be allowed to warm up until operating temperature has stabilized. The unit is considered to be at temperature stabilization when the **engine** oil temperature varies by less than 2°C (4°F) over 3 consecutive readings taken 15 minutes apart. As the unit warms up, the **load** may need to be adjusted to maintain maximum output wattage without exceeding **voltage** or frequency tolerances. Record **voltage**,*

amperage, frequency, wattage, oil and ambient air temperature several times during the test to show trends. When temperature stabilization has been reached record the barometric pressure and the humidity

- Calculate the Power Correction Factor based on the equation and standard conditions in Table 4 using the temperature, barometric pressure and the humidity recorded when the unit was at stable operating temperature*
- Calculate the Corrected Wattage by multiplying the Observed Wattage at temperature stabilization by the Power Correction Factor*
- When testing units for compliance to this standard, Corrected Wattage at temperature stabilization shall be a minimum of 90% of Nameplate **Rated Wattage***

6.4 Manufacturing Tests

All of the following tests shall be performed as "end-of-line " production tests on **portable generators**:

6.4.1 Frequency setting

*A **portable generator** which relies on **engine** speed for control of output frequency shall be tested to confirm its frequency setting and, if necessary, adjust to the desired **engine** speed. The frequency setting shall be within 5% of the nameplate rating.*

6.4.2 Power

*All **portable generators** shall be tested to confirm their ability to produce at least 70% of its rated output current.*

6.4.3 Voltage

*Each **receptacle** of a **portable generator** shall be tested to confirm that the correct nominal **voltage** is present while the unit is operational. The measured **voltage** setting shall be within 10% of the nameplate rating.*

6.4.4 Engine shutoff means

*All **portable generators** shall be tested to confirm the correct operation of the **engine** shutoff means.*

6.4.5 Dielectric voltage withstand test

*All **portable generators** shall pass the dielectric **voltage** withstand test of 6.2.9. The test may be performed using 120% of the specified **voltages** applied for 1 second.*

Note: The control box and **portable generator** may be tested separately before completing the assembly.

6.4.6 Leakage testing

*For **portable generators** that use LPG fuel, all tubing, hoses and fittings shall be tested after assembly and proved free from leaks at not less than normal operating pressures. Tubing, hoses and fittings shall be tested and proved free of leaks by applying a soap and water solution to connection points and verifying that no bubbles appear, or other equivalent means.*

7 Product and Packaging Labeling

7.1 Output Rating/Rating Plate

7.1.1 The **portable generator** output rating shall be included on packaging and reported per 6.3.2.

Compliance is checked by inspection.

7.1.2 The **portable generator** rating plate shall contain the following information:

- Manufacturer's name
- Nominal frequency
- Power factor (if other than 1.0)
- Output power rating in watts or kilowatts per 6.3.2
- Nominal **voltage** corresponding to the output rating
- Rated amperes corresponding to the output rating
- Rated speed in revolutions per minute
- Rated ambient temperature (T_{Rated} in accordance with 6.2.1.1)

Compliance is checked by inspection.

7.2 Danger, Warning and Caution Labels

7.2.1 Danger, Warning, and cautionary markings shall be designed to meet the intent of ANSI Z535.4-2011 or equivalent if not directed otherwise in this standard.

Compliance is checked by inspection.

7.2.2 Product Markings

7.2.2.1 **Portable generators** shall be marked to warn of the dangers of carbon monoxide poisoning according to Title 16 of the Code of Federal Regulations Part 1407.

Compliance is checked by inspection.

7.2.2.2 Hazard labels shall be designed to remain permanently affixed, intact, legible, and largely unfaded in the environment in which the product is expected to be operated and stored over the life of the product.

Compliance is checked by manufacturer supplied documentation.

7.2.2.3 Hazard labels shall be located on a part of the **portable generator** not normally removed for maintenance or service.

Compliance is checked by inspection.

7.2.2.4 In addition to 7.2.2.1 above, as applicable, each **portable generator** shall be marked in a readily visible location to address the following:

- Read operator's manual;
- Use of carbon monoxide alarms;
- Fuel fire hazard;
- Combustible material fire hazard;
- Shock hazard; and
- Hot parts hazard.

Compliance is checked by inspection.

7.2.2.5 **Portable generators** provided with fuses for output power shall have a marking for each fuse indicating the type of fuse to be used for replacement.

Compliance is checked by inspection.

7.2.3 Packaging Markings

7.2.3.1 **Portable generator** packaging shall be marked to warn of the dangers of carbon monoxide poisoning according to Title 16 of the Code of Federal Regulations Part 1407.

Compliance is checked by inspection.

7.3 Grounding

7.3.1 Labeling shall include status of the AC neutral conductor, marked on each **portable generator**, as follows:

- NEUTRAL FLOATING; or
- NEUTRAL BONDED TO FRAME.

This label shall be readily visible in the AC **receptacle** area(s). Where provision has been made to connect or disconnect the neutral conductor from the **portable generator** frame, such provision shall be clearly indicated in the marking.

Compliance is checked by inspection.

7.3.2 Labeling shall include status of DC output **receptacles** (if provided), marked on each **portable generator**, as follows:

- SYSTEM FLOATING; or
- SYSTEM BONDED TO FRAME.

This label shall be readily visible in the DC output **receptacle** area(s).

Compliance is checked by inspection.

7.3.3 The ground connection point on the **portable generator** shall be labeled with at least one of the following:

- a green color of the field grounding means described in subclause 5.6.3;
- GROUND;
- GND;
- with the letters "G" or "GR";
- clearly identified on a wiring diagram attached to the **portable generator**;
- Symbol 5019 of IEC 60417 (see Figure 5);
- The symbol \perp ; or
- Symbol 5020 of IEC 60417 (see Figure 6).

Compliance is checked by inspection.

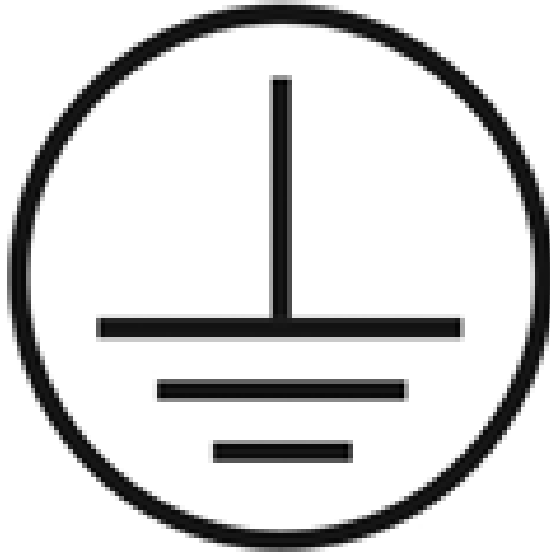


Figure 5 - Symbol 5019 of IEC 60417⁴



Figure 6 - Symbol 5020 of IEC 60417⁴

⁴ IEC 60417 Database Copyright © 2014 IEC Geneva, Switzerland. www.iec.ch

7.3.3.1 If only symbol 5019 of IEC 60417 is used to identify the field grounding means, then the following requirements also apply:

- the symbol shall be described in the instruction manual; and
- the symbol shall not be used at any location other than the field grounding means.

However, it is acceptable to use the symbol without the circle in locations other than the field grounding means, to indicate points that are bonded to the **portable generator** frame.

Compliance is checked by inspection.

7.4 Packaging

Package labeling content is at the manufacturer's discretion with the exception of Warnings as detailed in 7.2.3. Performance ratings marked on the packaging shall be in accordance with the test results of 6.3.

Compliance is checked by inspection.

8 Operators Manual, Operating Instructions and Warnings

8.1 A **portable generator** shall be provided with an operator's manual that includes specifications, assembly, operation, maintenance, moving and storage instructions and carbon monoxide alarm requirements as applicable. Instructions pertaining to the risk of carbon monoxide poisoning, fire, shock or other personal injury hazards associated with the **portable generator** shall also be provided.

Compliance is checked by inspection.

8.2 Product safety information shall be presented per ANSI Z535.6- 2011 or equivalent if not directed otherwise in this standard.

Compliance is checked by inspection.

8.3 Status of the Neutral Conductor

8.3.1 For **portable generators** where the neutral is bonded to the frame, the operator's manual shall include the following wording or equivalent:

- There is a permanent conductor between the **portable generator** stator winding and the frame.

Compliance is checked by inspection.

8.3.2 For **portable generators** where the neutral is bonded to the frame and where provision has been made to connect or disconnect the neutral conductor from the machine frame, such

provision shall be indicated. This indication may be satisfied by an instruction to contact the manufacturer.

Compliance is checked by inspection.

8.3.3 For **portable generators** where the neutral is floating, the operator's manual shall include the following wording or equivalent:

- The **portable generator** stator winding is isolated from the frame and from the AC **receptacle** ground pin; and
- Electrical devices that require a connection between one conductor pin and the grounded **receptacle** pin may not function properly.

Compliance is checked by inspection.

8.4 Assembly instructions shall be provided as applicable.

Compliance is checked by inspection.

8.5 For **portable generators** that use LPG fuel, recommended LP tank sizes shall be provided.

Compliance is checked by inspection.

8.6 Operation

The operator's manual shall include the following instructions for operation:

- Where to locate the **portable generator** for safe operation (e.g. carbon monoxide, fire, electrocution);
- Use of carbon monoxide alarm(s) with battery backup installed according to the alarm manufacturer's instructions;
- Identification of product hazard labels and their locations as applicable;
- Identification of controls, features, handles, lifting means and a description of their use as applicable;
- Proper electrical cord selection information as applicable;
- **Portable generator** inspection and any accessory items for damage prior to use (e.g. fuel system, **receptacles**, exhaust system, wiring, extension cords), and to repair/ replace as applicable;
- Specific fuel, oil and coolant specifications, including capacities required, as applicable;
- How to start, operate and stop the **portable generator**;
- Battery specifications as applicable;
- Connection of the product to a building's electrical system, as applicable. These instructions shall include the need for a transfer switch installed by licensed electricians who are approved by the authority having jurisdiction. The installation must comply with all applicable laws and electrical codes.

Compliance is checked by inspection.

8.7 Maintenance

8.7.1 Instructions shall be provided for installation, inspection or replacement of items intended to be serviceable by the user (e.g. oil change, filters, fuel valve, spark arrester, spark plug, battery, fuse, **engine** cooling system) as applicable.

Compliance is checked by inspection.

8.7.2 Instructions shall be provided for cleaning and care of the **portable generator**, as applicable.

Compliance is checked by inspection.

8.8 Storage

Information shall be provided on recommended short term and long term storage procedures, as applicable.

Compliance is checked by inspection.

8.9 A troubleshooting guide shall be provided as applicable.

Compliance is checked by inspection.

9 Normative References

ANSI/NEMA MW 1000 - 2011, *Magnet Wire*

ANSI/NEMA WD 6 - 2002 (R2008), *Wiring Devices - dimensional specifications*

ANSI/UL 1446, January 2008, *Systems of Insulating Materials - General*

ANSI Z21.81-2005, *Cylinder Connection Devices*

ANSI Z535.4-2011, *Product Safety Signs and Labels*

ANSI Z535.6-2011, *Product Safety Information in Product Manuals, Instructions, and Other Collateral Materials*

ANSI/OPEI B71.10 - 2013, *Off-Road Ground-Supported Outdoor Power Equipment - Gasoline Fuel Systems - Performance Specifications and Test Procedures*

Code of Federal Regulations, *Title 16, Part 1407*

CSA C22.2 No 100-14, *Motors and Generators*

IEC 60034-1: 2010, *Rotating electrical machines - Part 1: Rating and performance*

IEC 60085: 2007, *Electrical Insulation - Thermal evaluation and designation*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60529: 1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 61032: 1997, *Protection of persons and equipment by enclosures - Probes for verification*

IPC-2221B, November 2012, *Generic Standard on Printed Board Design*

NFPA 70, *National Electric Code, 2014 Edition*

SAE J1349, March 2008, *Engine Power Test Code - Spark Ignition and Compression Ignition - Net Power Rating.*

UL 94, March 2013, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 569, November 2013, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*

UL 746C, August 2013, *Polymeric Materials - Use in Electrical Equipment Evaluations*

UL 796, October 2010, *Standard for Printed-Wiring Boards*

UL 943, April 2011, *Ground-Fault Circuit-Interrupters*

UL 1439, February 1998, *Standard for Tests for Sharpness of Edges on Equipment*

UL 2201, March 2009, *Standard for Safety - Portable Engine-Generator Assemblies*

USDA Forest Service Standard 5100-1d, February 2013, *Standard for Spark Arrestors for Internal Combustion Engines*

Bibliography

Exponent Failure Analysis Associates, *Hot Surface Ignition - Unraveling the Myths*



PGMA – The Portable Generator Manufacturers' Association is North America's leading trade association of manufacturers of portable generators. With Association headquarters based in Cleveland, Ohio, our member companies include the major manufacturers of portable generators sold in North America. Since we represent a significant majority of the industry, we are the recognized voice of the portable generator industry.

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