UL 2201

STANDARD FOR SAFETY

Carbon Monoxide (CO) Emission Rate of Portable Generators

UL Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, UL 2201

Second Edition, Dated January 9, 2018

Summary of Topics

This revision of ANSI/UL 2201 dated February 24, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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.

The requirements are substantially in accordance with Proposal(s) on this subject dated November 4, 2022.

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UL 2201

Standard for Carbon Monoxide (CO) Emission Rate of Portable Generators

The first edition was titled Portable Engine-Generator Assemblies.

First Edition – March, 2009

Second Edition

January 9, 2018

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through February 24, 2023.

The most recent designation of ANSI/UL 2201 as a Reaffirmed American National Standard (ANS) occurred on February 24, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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 https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 This standard describes the testing procedures and requirements applicable in determining the carbon monoxide (CO) emission rate of a portable generator and also testing procedures and requirements applicable in determining the shutoff capability of a portable generator in elevated carbon monoxide (CO) environments.

1.2 These requirements apply to spark-ignited engines installed in portable generators for each fuel type recommended by the manufacturer.

2 Units of Measurement

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

3 Undated References

3.1 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.

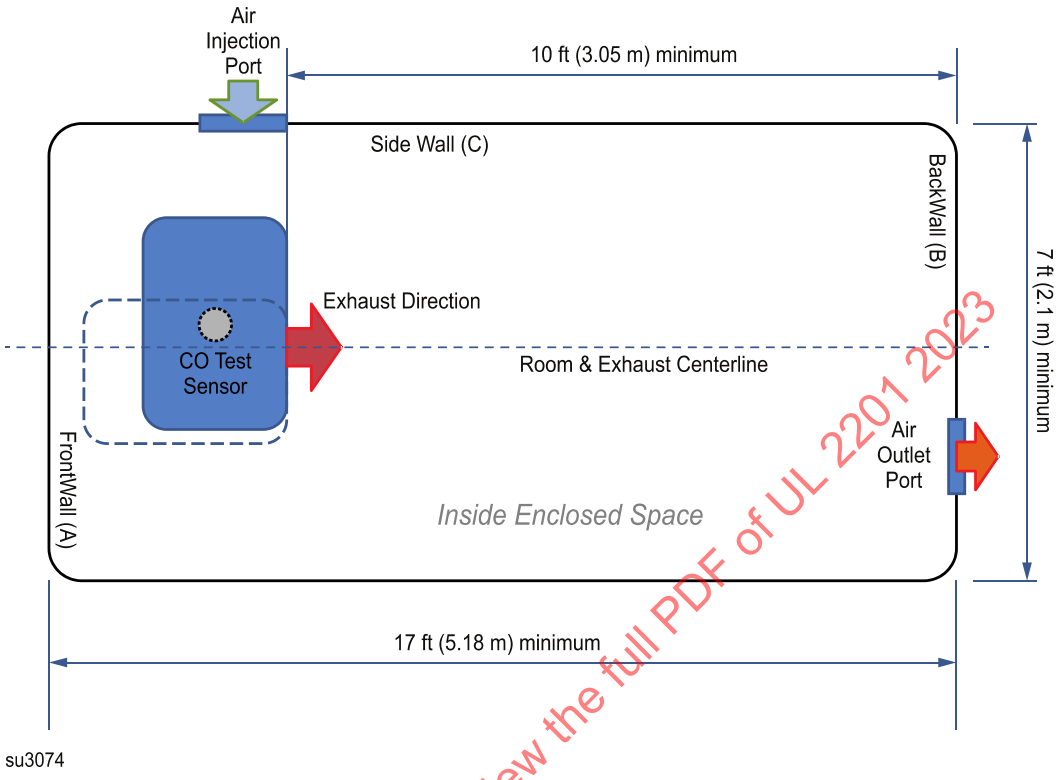
4 Definitions

4.1 For the purpose of this test method, the following definitions apply:

4.2 AIR INJECTION PORT – An inlet into the enclosed space having an opening that shall be no less than 25 in^2 (0.016 m^2) and no greater than 50 in^2 (0.032 m^2) and located on the Side Wall (C) at least 10 ft (3.05 m) from the Back Wall (B) as shown in Figure 4.1.

Figure 4.1

Enclosed space test room



4.3 AIR OUTLET PORT – An outlet allowing air to exit from the enclosed space that has an opening that shall be no less than 50 in^2 (0.032 m^2) and no greater than 288 in^2 (0.186 m^2), located on the Back Wall (B), and positioned between the centerline of the room and the opposite wall of the air injection port as shown in Figure 4.1.

4.4 CO METER – Meter capable of measuring CO levels at 1 Hz with accuracy requirements prescribed in the Code of Federal Regulations, (CFR) 40, Part 1065.

4.5 EMISSION MEASUREMENT SYSTEM – A constant volume sampling (CVS) or raw gaseous emission measurement system must meet the requirements of the Code of Federal Regulations, (CFR) 40, Parts 1054 and 1065.

4.6 ENCLOSED SPACE – A test room that encloses the portable generator that has an overall air volume between 900 – 1250 ft^3 (25.49 – 35.40 m^3) and that is rectangular in configuration with a general size guideline of 17 ft × 17 ft × 8 ft (5.18 m × 5.18 m × 2.44 m) as an example. The test room should include two ports that will be located on each end of the enclosed space as indicated in Figure 4.1, with the port closest to the generator acting as a forced fresh air inlet and the other port downstream of the generator exhaust acting as a natural air outlet.

4.7 LOAD BANK AND POWER METER – An AC electric resistor load bank is used to simulate steady electric loads on the generator. The load bank is capable of adjustment of ±5% of each required load condition. A power meter is used to measure the actual electrical load delivered by the generator with an accuracy of ±5%.

4.8 MAXIMUM AVAILABLE OBSERVED WATTAGE – The maximum output power measured in accordance with Safety and Performance of Portable Generators, ANSI/PGMA G300.

4.9 PPM – Gas concentration in parts per million.

PERFORMANCE

5 Test Method Options to Determine the Carbon Monoxide Emissions Rate

5.1 General

5.1.1 The carbon monoxide (CO) emission rate of a portable generator shall be obtained using a single representative generator test assembly subjected to the tests described in Sections 5.2 or 5.3 and shall pass all criteria as described in Section 6.5.

5.1.2 The CO emission rate is to be determined by either testing with the engine installed in the generator in the configuration to be sold by the generator manufacturer in an ambient oxygen environment (approximately 20.9%) or by testing the standalone Class I or Class II engine per applicable EPA standards.

5.1.3 The shutoff capability is to be determined by testing with the engine installed in the generator in the configuration to be sold by the generator manufacturer.

5.1.4 Fuel and lubricants must meet manufacturer's specifications for the generator or engine being tested.

5.2 Portable Generator Assembly CO Emissions Method – Option 1

5.2.1 The weighted CO emission rate of a portable generator is to be obtained by determining the modal CO emission rates at six discrete generator loads at ambient oxygen. All tests shall be performed at an ambient air temperature of 15 – 35°C (59 – 95°F). Measure the CO emission using an emission measurement system.

5.2.2 Calculate the weighted CO emission rate of the generator using the following equation:

$$\dot{m}_w = 0.09 \times \dot{m}_1 + 0.20 \times \dot{m}_2 + 0.29 \times \dot{m}_3 + 0.30 \times \dot{m}_4 + 0.07 \times \dot{m}_5 + 0.05 \times \dot{m}_6$$

In which:

$\dot{m}_w$ = *Weighted CO Emission Rate, gram per hour (g/h)*

$\dot{m}_1$ = *CO Emission Rate at mode 1 (g/h)*

$\dot{m}_2$ = *CO Emission Rate at mode 2 (g/h)*

$\dot{m}_3$ = *CO Emission Rate at mode 3 (g/h)*

$\dot{m}_4$ = *CO Emission Rate at mode 4 (g/h)*

$\dot{m}_5$ = *CO Emission Rate at mode 5 (g/h)*

$\dot{m}_6$ = *CO Emission Rate at mode 6 (g/h)*

5.2.3 The modal CO emission rate is to be measured using an emission measurement system and is to be determined at six loads as described in 5.2.5 – 5.2.7 using calculations consistent with those provided in accordance with the Code of Federal Regulations, (CFR) 40, Part 1065. When each modal result is completed, the weighted CO emission rate shall be determined in accordance with 5.2.2.

5.2.4 At an ambient air temperature of 15 – 35°C (59 – 95°F), start the portable generator and warm at any speed at approximately 75% of its output power rating for 10 min.

5.2.5 With the generator still running, adjust the load bank to apply the first load listed below.

a) Generator mode 1 power: 100% of the maximum available observed wattage

b) Generator mode 2 power: 75% of the maximum available observed wattage

c) Generator mode 3 power: 50% of the maximum available observed wattage

d) Generator mode 4 power: 25% of the maximum available observed wattage

e) Generator mode 5 power: 10% of the maximum available observed wattage

f) Generator mode 6: No load applied

5.2.6 Sample emissions in accordance with the Code of Federal Regulations, (CFR) 40, Part 1065, for at least 2 minutes with the prescribed load applied then stop emission sampling. Record the data and then calculate the mean CO emission values for that load.

5.2.7 Repeat this test for each load indicated in 5.2.5. Note that prescribed power levels achievable for each mode may be different than the prescribed percentage of load desired depending on the power available at the test condition.

5.2.8 The calculated weighted CO emission rate of the generator should not exceed 150 g/h using the formula in 5.2.2.

5.3 Portable Generator Engine Only CO Emissions Method – Option 2

5.3.1 This method to determine the weighted CO emission rate can be used for Class I and Class II portable generator engines. The emissions rate is to be obtained in accordance with the Code of Federal Regulations, (CFR) 40, Part 1065.

5.3.2 The following formula should be used to determine the weighted CO emission values of a Class I or Class II generator engine:

$$\text{Calculated weighted CO rate (g/h)} = \text{ECL} \times \text{MP} \times \text{LF}$$

In which:

ECL = EPA Certification Level in (g/kWh)

MP = Max. Power as specified in EPA Application (kW)

LF = Load Factor for Class I or Class II = 0.47

5.3.3 The calculated weighted CO emission rate of the generator engine should not exceed 150 g/h using the formula in 5.3.2.