United States
Consumer Product Safety Commission

This document was electronically approved and signed.

THIS MATTER IS NOT SCHEDULED FOR A BALLOT VOTE

A DECISIONAL MEETING FOR THIS MATTER IS SCHEDULED ON:

March 29, 2023

TO: The Commission
Alberta E. Mills, Secretary

DATE: March 8, 2023

THROUGH: Austin C. Schlick, General Counsel
Jason K. Levine, Executive Director

FROM: Daniel R. Vice, Assistant General Counsel, Regulatory Affairs
Barbara E. Little, Attorney, Regulatory Affairs

SUBJECT: Supplemental Notice of Proposed Rulemaking (SNPR): Safety Standard for Portable Generators

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Staff is forwarding to the Commission a briefing memorandum recommending that the Commission issue a Supplemental Notice of Proposed Rulemaking (SNPR) to address the risk of acute carbon monoxide poisoning associated with portable generators. The Office of the General Counsel is providing for the Commission's consideration a draft SNPR for portable generators pursuant to sections 7 and 9 of the Consumer Product Safety Act. The draft SNPR proposes to establish performance requirements for portable generators with a 180-day effective date following publication of the final rule in the *Federal Register*.

Please indicate your vote on the following options:

I. Approve publication of the SNPR in the *Federal Register*, as drafted.

_____ _____
(Signature) (Date)

U.S. Consumer Product Safety Commission
4330 East-West Highway
Bethesda, MD 20814

National Product Testing and Evaluation Center
5 Research Place
Rockville, MD 20850

United States
Consumer Product Safety Commission

II. Approve publication of the SNPR in the *Federal Register*, with the specified changes.

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_____

_____

_____ _____
(Signature) (Date)

III. Do not approve publication of the SNPR in the *Federal Register*

_____ _____
(Signature) (Date)

IV. Take other action specified below.

_____

_____

_____

_____

_____ _____
(Signature) (Date)

Attachment: Draft *Federal Register* notice "Supplemental Notice of Proposed Rulemaking: Safety Standard for Portable Generators"

U.S. Consumer Product Safety Commission
4330 East-West Highway
Bethesda, MD 20814

National Product Testing and Evaluation Center
5 Research Place
Rockville, MD 20850

Billing Code 6355-01-P

CONSUMER PRODUCT SAFETY COMMISSION

16 CFR Part 1241

[CPSC Docket No. CPSC–2006-0057]

Safety Standard for Portable Generators

AGENCY: Consumer Product Safety Commission.

ACTION: Supplemental Notice of Proposed Rulemaking; notice of opportunity for oral presentation of comments.

SUMMARY: The U.S. Consumer Product Safety Commission (Commission or CPSC) has preliminarily determined that there is an unreasonable risk of injury and death associated with acute carbon monoxide (CO) poisoning from portable generators. To address this hazard, the Commission proposes a rule under the Consumer Product Safety Act (CPSA) that limits CO emissions from portable generators and requires generators to shut off when specific emissions levels are reached. The Commission is providing an opportunity for interested parties to present comments on this supplemental notice of proposed rulemaking (SNPR).

DATES: *Deadline for Written Comments*: Written comments must be received by [**INSERT DATE THAT IS 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER**]. *Deadline for Request to Present Oral Comments*: Any person interested in making an oral presentation must send an electronic mail (e-mail) indicating this intent to the Office of the Secretary at cpsc-os@cpsc.gov by [**INSERT DATE THAT IS 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER**].

ADDRESSES: *Written Comments*: You may submit written comments in response to the proposed rule, identified by Docket No. CPSC-2006-0057, by any of the following methods:

Electronic Submissions: Submit electronic comments to the Federal eRulemaking Portal at: www.regulations.gov. Follow the instructions for submitting comments. CPSC typically does not accept comments submitted by e-mail, except as described below. CPSC encourages you to submit electronic comments by using the Federal eRulemaking Portal, as described above.

Mail/hand delivery/courier Written Submissions: Submit comments by mail/hand delivery/courier to: Office of the Secretary, Consumer Product Safety Commission, 4330 East West Highway, Bethesda, MD 20814; telephone: (301) 504-7479. If you wish to submit confidential business information, trade secret information, or other sensitive or protected information that you do not want to be available to the public, you may submit such comments by mail, hand delivery, or courier, or you may e-mail them to: cpsc-os@cpsc.gov.

Instructions: All submissions must include the agency name and docket number. CPSC may post all comments without change, including any personal identifiers, contact information, or other personal information provided, to: www.regulations.gov. Do not submit through this website: confidential business information, trade secret information, or other sensitive or protected information that you do not want to be available to the public. If you wish to submit such information, please submit it according to the instructions for mail/hand delivery/courier written submissions.

Docket for SNPR: For access to the docket to read background documents or comments received, go to: www.regulations.gov, insert the docket number CPSC–2006-0057 into the "Search" box, and follow the prompts.

FOR FURTHER INFORMATION CONTACT: Janet Buyer, Directorate for Engineering Sciences, Office of Hazard Identification and Reduction, Consumer Product Safety Commission,

National Product Testing and Evaluation Center, 5 Research Place, Rockville, MD 20850; telephone: 301-987-2293; jbuyer@cpsc.gov.

SUPPLEMENTARY INFORMATION:

I. Background

In 2006, the Commission published an advance notice of proposed rulemaking (ANPR) to consider whether there may be an unreasonable risk of injury and death from CO poisoning associated with portable generators.[1] The ANPR began a rulemaking proceeding under the CPSA.

Following publication of the ANPR, CPSC contracted with the University of Alabama (UA) to conduct a demonstration of prototype low CO emission technology for portable generators. CPSC also contracted with the National Institute for Standards and Technology (NIST) to conduct comparative testing of generators in an attached garage of a test house facility, and to perform indoor air quality (IAQ) modeling. CPSC staff published a report regarding the results of the UA technology demonstration and NIST's test results.[2] NIST published a report concerning the results of the comparative testing of generators as well as IAQ modeling they performed using their test results.[3]

[1] Portable Generators; Advance Notice of Proposed Rulemaking; Request for Comments and Information, 71 FR 74472 (Dec. 12, 2006) (Document ID number CPSC-2006-0057-0001 in www.regulations.gov).

[2] *Technology Demonstration of a Prototype Low Carbon Monoxide Emission Portable Generator* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/staff%20report%20on%20technology%20demonstration.pdf (Document ID number CPSC-2006-0057-0002 in www.regulations.gov).

[3] *NIST Technical Note 1781; Modeling and Measuring the Effects of Portable Gasoline Powered Generator Exhaust on Indoor Carbon Monoxide Level* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/CPSC%20staff%20cover%20statement%20and%20NIST%20TN%201781.pdf

In October 2016, staff delivered to the Commission a draft proposed rule to address the CO poisoning hazard associated with portable generators.[4] The draft proposed rule would have limited the CO emission rates of portable generators based on four different engine size categories. Staff estimated the proposed CO emission rates equated to reductions of approximately 75 percent for the smallest generators to approximately 90 percent for the two largest size categories, compared to the typical CO emission rates of current generators.

The Commission voted to approve publication of the draft proposed rule, and the proposed rule was published on November 21, 2016.[5] The Commission received written comments and oral presentations from the public. Section IX contains a summary of significant comments received and staff's responses to these comments.

Following publication of the NPR, Underwriters Laboratories (UL) and the Portable Generator Manufacturers Association (PGMA) each published new editions of their voluntary standards that included CO hazard mitigation requirements. UL published ANSI-approved UL 2201, *Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition*, on January 9, 2018 (UL 2201).[6] PGMA published ANSI-approved ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators*, on April 20, 2018 (PGMA G300).[7]

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[4] *CPSC Staff Briefing Package for Notice of Proposed Rulemaking For Safety Standard For Carbon Monoxide Hazard For Portable Generators, October 5, 2016*, https://www.cpsc.gov/s3fs-public/Proposed-Rule-Safety-Standard-for-Portable-Generators-October-5-2016.pdf (Document ID CPSC-2006-0057-0032 in www.regulations.gov).

[5] Notice of proposed rulemaking, *Safety Standard for Portable Generators*, 81 FR 83556 (Nov. 21, 2016) https://www.federalregister.gov/documents/2016/11/21/2016-26962/safety-standard-for-portable-generators

[6] *UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators*, *Second Edition*, Dated Jan. 9, 2018.

[7] *ANSI/PGMA G300-2018 (Errata Update), Safety and Performance of Portable Generators*, available online at https://www.pgmaonline.com/pdf/ANSI_PGMAG300-2018(ErrataUpdateApril2020).pdf. On May 1, 2020, PGMA issued an erratum update to PGMA G300-2018 that changed the requirement for packaging marking from a logo to the following text or equivalent wording: "This product complies with the ANSI/PGMA G300-2018 standard." References to "PGMA G300" in this document refer to ANSI/PGMA G300-2018 (Errata Update).

In 2019, the Commission announced the availability of and sought comment on NIST Technical Note 2048, "Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators."[8] NIST Technical Note 2048 represents a plan developed by CPSC staff and NIST staff to estimate the effectiveness of the CO mitigation requirements in PGMA G300 and UL 2201. In August 2020, the Commission announced the availability of a memorandum resulting from CPSC and NIST staffs' review of the comments received, including adjustments made to the simulation and analysis plan.[9,10]

In February 2022, CPSC staff reported to the Commission its findings regarding the effectiveness of the CO mitigation requirements in PGMA G300 and UL 2201, "*CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*."[11]

The Commission is issuing this supplemental notice of proposed rulemaking because the revised proposed rule, based on requirements from UL 2201 and PGMA G300 that did not exist at the time of the NPR, is likely to reduce the risk of CO injuries and deaths to a greater degree than those in the 2016 NPR. Additionally, the combination of requirements in this SNPR builds on industry's own standards, which should facilitate compliance. In particular, this SNPR adds requirements related to shutoff when high CO levels are detected, which have begun to achieve industry acceptance. The SNPR also adopts emissions requirements consistent with the UL 2201

[8] Notice of Availability: Plan to Evaluate CO Mitigation Requirements for Portable Generators, 84 FR 32729 (July 9, 2019), https://doi.org/10.6028/NIST.TN.2048.
[9] Notice of Availability: Revisions to the Plan Documented in NIST Technical Note 2048: Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators, 85 FR 52096 (Aug. 24, 2020).
[10] Staff memorandum, https://www.cpsc.gov/s3fs-public/revisions-to-TN2048-and-comment-resolutions.pdf (Document ID CPSC-2006-0057-0106 in www.regulations.gov).
[11] https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov).

standard, because both actual fatal incidents and scenario simulations show that an effective shutoff system alone is not sufficient to protect consumers from death and serious injury from accumulated CO.

The CO emission rates of portable generators are on the order of hundreds of times the CO emission rates of gasoline powered automobiles. From 2004 through 2021, there were at least 1,332 CO-related consumer deaths involving portable generators, or an average of about 74 lives lost annually, with thousands of non-fatal poisonings of consumers per year. Fatalities have increased in recent years. For example, for the three most recent years for which complete data are available (2017 through 2019), generator-related CO deaths have averaged 85 per year.

The Commission expects that the proposed rule would be highly effective in avoiding generator-related CO incidents, producing benefits that far exceed the estimated costs. Over 30 years, the Commission estimates the rule would prevent 2,148 deaths (nearly 72 deaths per year) and 126,377 injuries (roughly 4,213 injuries per year). The total benefits from the rule are estimated to be greater than $1 billion per year during this period, using a discount rate of 3 percent. This represents approximately $273 of benefits for each generator sold. Costs are far lower, such that the Commission estimates net benefits, with a discount rate of 3 percent, to be approximately $897 million per year. For every $1 in estimated direct cost to consumers and manufacturers, the proposed rule generates more than $7 in benefits from mitigated deaths and injuries.

The information discussed in this preamble is derived from CPSC staff's briefing package for the SNPR, "Staff's SNPR Briefing Package," which is available on CPSC's website at: [INSERT LINK]. For a more comprehensive and detailed discussion of the information in this preamble, see the Staff's SNPR Briefing Package.

II. Statutory Authority

This supplemental notice of proposed rulemaking is authorized by the CPSA. 15 U.S.C. 2051-2084. Section 7(a) of the CPSA authorizes the Commission to promulgate a mandatory consumer product safety standard that sets forth performance or labeling requirements for a consumer product if such requirements are reasonably necessary to prevent or reduce an unreasonable risk of injury. 15 U.S.C. 2056(a). Section 9 of the CPSA specifies the procedure that the Commission must follow to issue a consumer product safety standard under section 7 of the CPSA. The Commission commenced this rulemaking by issuing an ANPR.

According to section 9(f)(1) of the CPSA, before promulgating a consumer product safety rule, the Commission must consider, and make appropriate findings to be included in the rule, on the following issues:

- The degree and nature of the risk of injury that the rule is designed to eliminate or reduce;
- The approximate number of consumer products subject to the rule;
- The need of the public for the products subject to the rule and the probable effect the rule will have on utility, cost, or availability of such products; and
- The means to achieve the objective of the rule while minimizing adverse effects on competition, manufacturing, and commercial practices.

15 U.S.C. 2058(f)(1).

Under section 9(f)(3) of the CPSA, to issue a final rule, the Commission must find that the rule is "reasonably necessary to eliminate or reduce an unreasonable risk of injury associated with such product" and that issuing the rule is in the public interest. *Id.* 2058(f)(3)(A) & (B). Additionally, if a voluntary standard addressing the risk of injury has been adopted and implemented, the Commission must find that:

- The voluntary standard is not likely to eliminate or adequately reduce the risk of injury, *or*
- Substantial compliance with the voluntary standard is unlikely.

Id. 2058(f)(3)(D). The Commission also must find that expected benefits of the rule bear a reasonable relationship to its costs and that the rule imposes the least burdensome requirements that would adequately reduce the risk of injury. *Id.* 2058(f)(3)(E) & (F).

III. Product Description

A portable generator is a consumer product that converts chemical energy from the fuel powering the engine to rotational energy, which in turn is converted to electrical power. The engine can be fueled by gasoline, liquified propane gas (LPG), natural gas, or diesel fuel. The generator has a receptacle panel that consumers use to connect appliances, power tools, or other electrical loads to the generator via a plug connection. These generators are designed for portability—specifically, to be carried, pulled, or pushed by a person.

Manufacturers and retailers advertise portable generators by many different features, but one of the primary features is the amount of electrical power the generator can provide continuously. The industry commonly refers to this as "rated power," "rated wattage," or "running wattage," which ranges from less than 1,000 watts (1 kilowatt or 1 kW) to approximately 20 kW.

IV. Risk of Injury

A. Description of Hazard – Acute CO Poisoning

Portable generators produce CO. CO is a colorless, odorless, poisonous gas formed during incomplete combustion[12] of fossil fuels, which occurs in all fuel burning products to

[12] Incomplete combustion entails only partial burning of a fuel. CO is a byproduct from incomplete combustion of carbon.

varying degrees. Engines like those in portable generators emit CO along with other exhaust gas constituents that have noxious odors. Section II.B of the briefing memorandum in Staff's SNPR Briefing Package describes the effects of CO poisoning, and the relationship between exposure to CO and carboxyhemoglobin (COHb) levels in the body. Even after CO has reached a peak and is decreasing, such as when a generator shuts off, COHb will continue to rise for some time before it decreases.[13]

B. CO Fatalities Associated with Portable Generators

Based on the data from the reports in CPSC's databases as of May 10, 2022, there have been at least 1,332 deaths associated with generators for years 2004 through 2021.[14,15] Figure 1 shows the number of reported deaths involving a portable generator for each of the years in this period. Data for the two most recent years, 2020 and 2021, are incomplete, because data collection is ongoing, and the death count most likely will increase in future reports.[16]

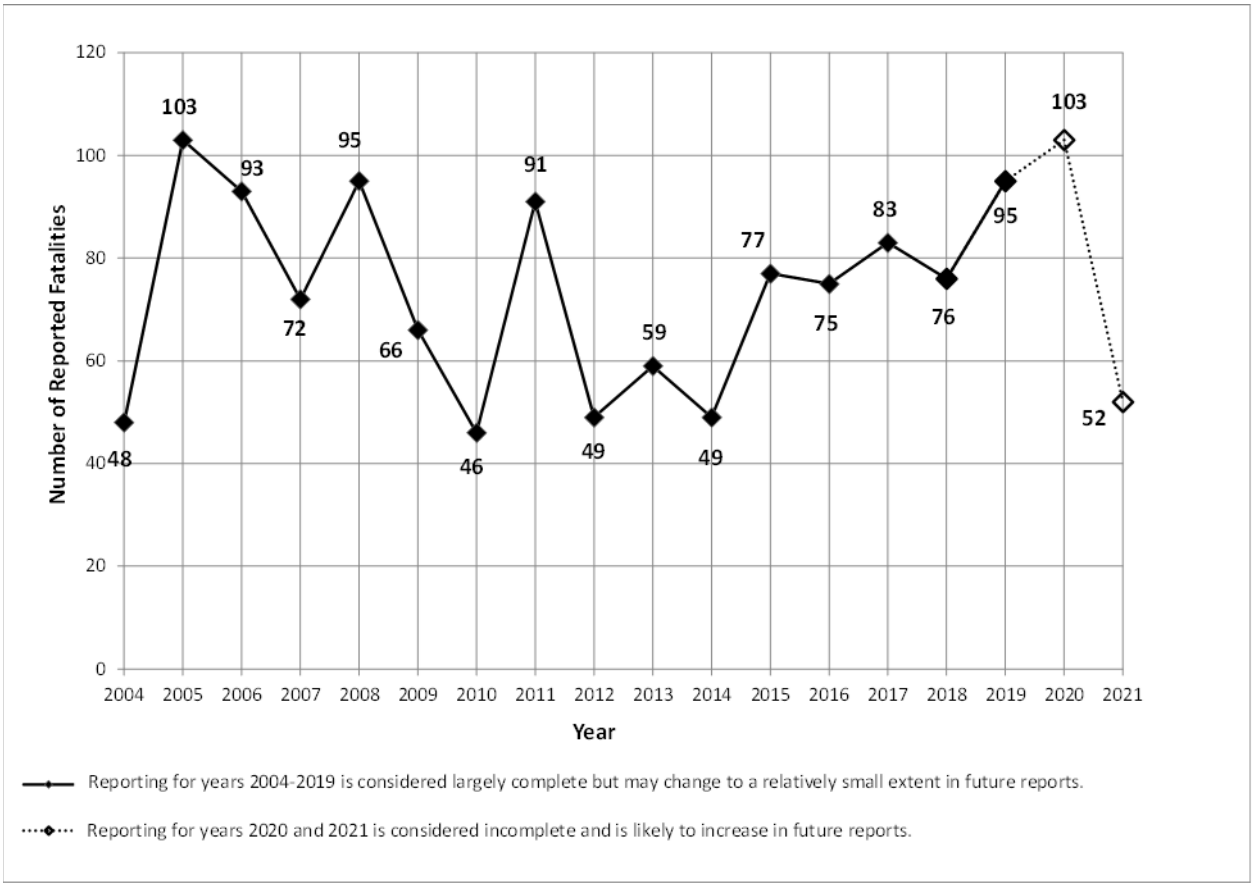
[13] This is exemplified in test results presented in NIST Technical Note 2049 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Portable Generators with a CO Safety Shutoff Operating in a Test House*, available online at https://doi.org/10.6028/NIST.TN.2049. In the vast majority of the tests, the peak COHb levels were attained hours after the generator shut off.

[14] Death data for years 2004 through 2010 are from the following report, with an additional death included in 2004 that was reported in the NEISS data but was not previously accounted for: Hnatov, M.V., *Generators Involved in Fatal Incidents, by Generator Category, 2004-2014*, CPSC, Bethesda, MD, Sept. 2016. (TAB B in https://www.cpsc.gov/s3fs-public/Proposed-Rule-Safety-Standard-for-Portable-Generators-October-5-2016.pdf; Document ID CPSC-2006-0057-0032 in www.regulations.gov).

[15] Death data for years 2011 through 2021 are from the following report, with 5 deaths from 3 incidents in 2011 excluded because they involved stationary generators, which are outside the scope of the proposed rule: Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*, CPSC, Bethesda, MD, June 2022 https://www.cpsc.gov/content/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021 (Document ID CPSC-2006-0057-0108 in www.regulations.gov).

[16] For example, in staff's annual report covering the years 2010 through 2020, the number of deaths entered in CPSC's databases as of May 17, 2021 for the years 2019 and 2020 was 89 and 54, respectively. The deaths in these years increased to 95 and 103, respectively, in the June 2022 report, for which the data were pulled almost exactly one year later. See https://www.cpsc.gov/content/Generators-and-OEDT-CO-Poisoning-Fatalities-Report-2021.

Figure 1. Number Of Reported Non-Fire CO Poisoning Deaths Involving Generators in CPSC Databases as of May 10, 2022, by Year, 2004-2021



The average number of generator-related CO fatalities in CPSC's databases for the most recent 3 years of complete data (years 2017 through 2019) is 85 deaths per year.

C. Hazard Patterns of Fatal Incidents

CPSC Field Staff conducted in-depth investigations (IDI) on nearly all 1,332 deaths represented in Figure 1 to gather more detailed information about the incidents and to

characterize the hazard patterns. Two annual reports covering the 18-year period[17,18] categorize the incidents and characterize the hazard patterns for these 1,332 fatalities, including, for example, the kind of structure in which the incident occurred (e.g., fixed-structure home, apartment, townhouse), the location of the generator, and the time of year of the incident.

D. CO Injuries from Portable Generators

Based on the CPSC's National Electronic Injury Surveillance System (NEISS) database, which is a national probability sample of approximately 100 hospitals in the United States and its territories, the Commission estimates that there were at least 23,318 CO injuries associated with generators that were seen in hospital Emergency Departments (EDs) for the 18-year period from 2004 through 2021. See Table 1.

[17] Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*, CPSC, Bethesda, MD, June 2022, https://www.cpsc.gov/content/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021 (Document ID CPSC-2006-0057-0108 in www.regulations.gov).

[18] Hnatov, M.V., *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 2004-2014*, CPSC, Bethesda, MD, June 2015, https://www.cpsc.gov/content/incidents-deaths-and-depth-investigations-associated-non-fire-carbon-monoxide-engine-1 (Document ID CPSC-2006-0057-0026 in www.regulations.gov).

Table 1. National Estimates of Injuries Associated with Generators Seen in Emergency Departments with Narratives Indicative of Carbon Monoxide Poisoning 2004-2021, By Disposition

NEISS Code	Treatment	Estimated Injuries	Coefficient of Variation	Sample Size	95% Confidence Interval
1	Treated and released, or examined and released without treatment	17,569	0.2612	450	8,575-26,563
6	Left without being seen/Left against medical advice				
2	Treated and transferred to another hospital	5,727	0.2864	149	2,512-8,942
4	Treated and admitted for hospitalization (within same facility)				
5	Held for observation (includes admitted for observation)				
8	Fatality, including dead on arrival, died in the ED, died after admission	*	*	1	*
9	Not recorded	*	*	1	*
	Total	23,318	0.2540	601	11,709-34,927

Source: U.S. Consumer Product Safety Commission National Electronic Injury Surveillance System and Children and Poisoning System, 2004- 2018.
Rows may not sum to the total due to rounding.
*Too few observations to produce an estimate

Staff also estimated CO injuries using CPSC's Injury Cost Model (ICM). The ICM estimates injuries treated in locations other than hospital EDs. For the years 2004 through 2021, staff estimates 1,580 injuries resulted in direct hospital admissions and 52,782 injuries resulted in a doctor's or clinic's visit. Combined with the NEISS estimates stated previously, this means that there were an estimated 77,658 nonfatal injuries that were treated in the same 18-year period. See Tab A of Staff's SNPR Briefing Package.

V. Voluntary Standards

To issue a final rule under section 9(f)(3) of the CPSA if a voluntary standard addressing the risk of injury has been adopted and implemented, the Commission must find that:

- The voluntary standard is not likely to eliminate or adequately reduce the risk of injury, *or*
- Substantial compliance with the voluntary standard is unlikely.

As mentioned in section I of this preamble, there are two voluntary standards with CO mitigation requirements intended to address the risk of acute CO poisoning from portable generators: UL 2201 and PGMA G300.

A. UL 2201

In 2002, UL convened a standards technical panel (STP) of stakeholders with varied interests and backgrounds to develop requirements for their safety standard for portable generators, UL 2201. On January 9, 2018, the STP voted to approve, and UL published, the ANSI-approved second edition of UL 2201.

Section 1 of UL 2201 2nd Edition provides that the requirements in UL 2201 apply to spark-ignited engines installed in portable generators for each fuel type recommended by the manufacturer.

Section 5.2.8 and section 5.3.3 of UL 2201 specify that the calculated weighted CO emission rate[20] of a generator shall not exceed 150 g/h, using the formula specified in sections 5.2.2 and 5.3.2 of UL 2201, respectively. Section 5.2.2 involves testing with the engine installed in the generator assembly, in the configuration when the consumer purchases it. Section 5.3.2 involves testing the standalone engine in accordance with the U.S. Environmental Protection Agency's (EPA) engine emission test procedure defined in Engine Testing Procedures, 40 CFR part 1065.

UL 2201 also includes shutoff requirements. Under section 6.5 of UL 2201 the generator must shut off when the CO concentration registers either:

[20] The weighted CO emission rate is calculated from the emission rates that are measured while each of six different prescribed loads are applied to either the engine or the generator (depending on which of the two the test methods in the proposed rule is used) and multiplying each emission rate with a prescribed weight factor, then summing the product of weight factor and emission rate for each of the six loads.

1. 150 parts per million by volume (ppmv) of CO during a 10-minute rolling average[21] (§ 6.5.3), or
2. an instantaneous reading of 400 ppmv (§ 6.5.2).[22]

For the test method to verify compliance with the CO shutoff requirements, the generator is operated in a closed room and the room CO concentration is measured 1 foot above the centerline (the geometric center) of the generator. The generator must shut off when the CO measured above the generator meets either one of the shutoff concentrations. Any product certified to UL 2201 after publication of the 2nd Edition on January 9, 2018, must meet the requirements of the 2nd Edition.

B. PGMA G300-2018

In late 2016, PGMA's technical committee began developing CO hazard-mitigation requirements for its own standard, PGMA G300-2015. PGMA's efforts culminated on April 20, 2018, after a canvass committee of stakeholders with varied interests and backgrounds voted to approve, and PGMA published, the ANSI-approved 2018 edition of PGMA G300.

Section 1 of PGMA G300-2018 provides that the 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 to be moved, though not necessarily with wheels." According to section 1 of PGMA G300, 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

[21] A rolling average is a calculation averaging data over an interval of time that changes its initial point and end point as specified by the duration of the time interval.
[22] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

output circuits that are not compatible with NEMA receptacles are not included within the scope of the standard.

PGMA G300-2018 has shutoff system requirements but does not have CO emission rate requirements. PGMA G300 includes a requirement for generators to be equipped with an onboard CO sensor that is certified to appropriate requirements in the U.S. voluntary standard for residential CO alarms, *UL 2034, Standard for Safety, Single and Multiple Station Carbon Monoxide Alarms*. Section 6.2.11.1 provides the acceptance criteria for the CO shutoff system. The CO sensor, when tested to the requirements in the standard, must shut off the generator before the CO concentration, when measured at a location 1 to 2 inches above the approximate center of the portable generator's top surface, exceeds either 400 ppmv for a 10-minute rolling average of CO, or an instantaneous reading of 800 ppmv.

PGMA G300-2018 section 3.9.1.1 includes requirements for a self-monitoring system to detect the correct operation of the CO sensing element, loss of power source for the portable generator system for controlling CO exposure, and the end of life of the CO sensor. The standard requires that the self-monitoring system shut off the portable generator engine upon fault detection and end of life.

Section 3.9.1.2.1 requires that the portable generator system for controlling exposure be tamper resistant and specifies when a system is considered tamper resistant. According to section 3.9.1.2.1, the system is considered tamper resistant when all parts that affect the proper operation of the portable generator system for controlling CO exposures meet at least one of the following: (1) the part is permanently sealed; (2) the part is not normally accessible by hand or with ordinary tools; or (3) removal or disconnection of the part prevents the engine from running. Section 3.9.1.2.1 allows for different parts of the portable generator system that control exposure

to meet the requirement for tamper resistance using any of the options, provided all of the different parts meet at least one of the options.

Section 3.9.1.2.2 of PGMA G300-2018 requires that construction of the portable generator minimize the risk of intentional blockage of the gas inlet of the portable generator system for controlling CO exposure. Section 3.9.1.2.3 provides that the construction of the portable generator shall minimize the risk of incidental damage to the portable generator system for controlling CO exposure. Section 3.9.1.2.4 provides that the portable generator system for controlling CO exposure shall not incorporate any type of override function or feature.

PGMA G300-2018 includes construction and performance requirements for the CO sensor. Section 3.9.1 and 3.9.1.4 of PGMA G300 include requirements from UL 2034, *Single and Multiple Station Carbon Monoxide Alarms,* to address the construction and performance of the CO safety shutoff system.[23] UL 2034 provides design and performance requirements for CO alarms that cover topics related to the construction of the CO shutoff system such as gas and vapor interference, dust exposure, vibration, corrosion, and extreme temperature and humidity exposure. Additionally, section 3.9.1.4 of PGMA G300 requires that the shutoff system contain a carbon monoxide sensing element bearing a UL mark or equivalent Nationally Recognized Testing Laboratory (NRTL) mark, to indicate that the sensor is capable of meeting the requirements for use in UL 2034 compliant systems.

PGMA G300-2018 also requires notification after a shutoff event. The PGMA G300 shutoff "notification" requirements consist of a "red indication" (§ 3.9.1.3.1) and associated product markings (§ 7.2.2.4).

[23] Edition Date: March 31, 2017; ANSI approved: October 7, 2022. UL 2034 is available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=32610.

The notification is required to be "a red indication," but the indication is not required to be a light. The standard allows, but does not require, the indication to be "blinking, with a maximum period of 2 seconds." § 3.9.1.3.1. The indication must remain for a minimum of 5 minutes after shutoff occurs unless the generator is restarted. Sections 3.9.1.3, 3.9.1.3.1, and 4.1.1.3 of PGMA G300 prescribe additional requirements for the indication.

PGMA G300 also requires product markings that relate to the notification system. These markings include the following, which must be "in a readily visible location" (§ 7.2.2.4):

- An identification of the hazard associated with tampering with the CO shutoff system.
- An identification and description of the CO shutoff system notifications that are "in close proximity to each CO shutoff notification."
- An identification of the direction of the engine exhaust, including instructions to direct the exhaust away from occupied structures.
- A label about the automatic shutoff that instructs the consumer to move the generator to an open, outdoor area; point the exhaust away; not to run the generator in enclosed areas; and move to fresh air and get medical help if sick, dizzy, or weak. See Tab F of SNPR Staff Briefing Package. The label must be "in close proximity to the notification."

C. Assessment of Compliance with UL 2201 and PGMA G300

In a February 1, 2023, letter to CPSC, PGMA states that at the end of 2022, "over 68% of PGMA member company generators shipped complied with the CO shutoff requirement in PGMA G300."[24] This number, however, is limited to PGMA member companies, which

[24] See https://www.regulations.gov/search?filter=cpsc-2006-0057-0111%20.

represent a small fraction of all generator manufacturers (although those manufacturers account for a substantial percentage of total sales).

In 2021 and 2022, CPSC staff surveyed manufacturers regarding their production of compliant generators.[25] In both surveys, three manufacturers indicated that most or all their models comply with PGMA G300, and one of these manufacturers also stated its models are compliant with UL 2201. In 2021, four other manufacturers reported that their compliance rates with PGMA G300 were expected to increase substantially in the next year. However, in 2022, one of these firms responded to the updated 2022 survey and reported compliance rates that fell short of their target established the prior year. Based on this review, the unabated number of incidents as shown in Figure 1, and the market analysis discussed below, the Commission concludes that compliance with UL 2201 is limited while compliance with PGMA G300, although greater, is not sufficient to significantly reduce the risk of injury and death. Based on information provided by manufacturers and in market research, staff estimates a 30 percent compliance rate with PGMA G300's sensor and shutoff requirements as of 2022. One sixth of those PGMA-compliant units (or 5 percent of the total) are estimated to also be compliant with the emissions requirements of UL 2201. Even if compliance with PGMA G300 is greater than the estimated 30 percent, the G300 standard does not appear at present to have substantial compliance. Additionally, the Commission, as described in section IV.D of this preamble, assesses that the requirements in PGMA G300 are inadequate to reduce the risk of acute CO poisoning associated with portable generators.

D. Assessment of UL 2201 and PGMA G300

[25] Staff conducted surveys of a subset of large manufacturers in 2021 and 2022. In 2022, in addition to assessing compliance with the voluntary standards, staff obtained cost information regarding the required modifications to make portable generators compliant with each of these voluntary standards.

1. CO Emission Rate and Shutoff Levels

To evaluate the effectiveness of the CO mitigation requirements in UL 2201 and PGMA G300-2018, CPSC staff worked with NIST to simulate the scenarios of 511 fatalities that are known to CPSC, using an indoor air quality (IAQ) modeling program called "CONTAM."[26] The 511 simulations are based on the actual deaths found in CPSC records over the 9-year period from 2004 through 2012 that occurred at fixed residential structures or similar structures. Staff completed approximately 140,000 simulations for 37 different house models and three detached garages, with various generator locations and generator sizes in 28 different weather conditions. Staff's briefing package, "Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard" (Feb. 16, 2022) provides a detailed description of these simulations.[27]

Staff's analysis of the simulation results found that under simulated conditions, generators compliant with the CO emission rate and shutoff requirements of the UL 2201 standard would avert nearly all of the 511 deaths, or nearly 100%, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. Staff's analysis found that generators compliant with the shutoff requirements of the PGMA G300-2018 standard would avert about 87 percent of the 511 deaths, resulting in 69 deaths, with 54 survivors requiring hospitalization and 88 survivors seeking medical treatment and being released. The results of that analysis are shown in Table 2.[28]

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[26] CONTAM is a multizone airflow and contaminant transport IAQ modeling program that was developed by NIST and has been used for several decades. It accurately models the buildup and transport of contaminants within, into, and out of a building. (Why delete?)

[27] https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document Id number CPSC-2006-0057-0107 in www. Regulations.gov).

[28] Some of the results differ slightly from those previously published in staff's briefing package on effectiveness of the voluntary standards because staff found a tabulation error in the analysis of the simulation results after publication. See Tab A of Staff's SNPR Briefing Package.

Table 2. **Results of effectiveness analysis of voluntary standards, based on simulations of 511 CO deaths in CPSC databases from generators, 2004-2012**

Outcome for Operators and Collateral Occupants	Baseline vs. Standards		
	Baseline	G300	UL 2201
Fatality	511	68.50	0.04
Percentage of death averted versus baseline generators	- -	86.6%	99.99%
Survivors who are hospitalized or transferred to specialized treatment center	- -	54.22	3.22
Survivors who seek medical treatment and are treated and released	- -	87.96	24.28
Survivors who are likely not symptomatic and not seeking medical treatment	- -	300.42	483.56

2. Estimates of Deaths and Injuries Assuming Compliance with Either Voluntary Standard

This section discusses the fatalities in CPSC databases and provide estimates of generator-related CO deaths and injuries seen in EDs, if generators meeting either voluntary standard had been involved in those incidents. At least 1,332 fatalities occurred from 1,009 separate incidents in CPSC's databases as of May 10, 2022, for the 18-year period 2004 through 2021.[29,30]

The Commission applied the information from the simulations and actual fatal incidents to the NEISS injury estimates (and inputs from the Injury Cost Model) to derive the estimates of

[29] Death data for years 2004 through 2010 are from the following report, with an additional death included in 2004 that was reported in the NEISS data but was not previously accounted for: Hnatov, M.V., *Generators Involved in Fatal Incidents, by Generator Category, 2004-2014*, U.S. U.S. Consumer Product Safety Commission, Bethesda, MD, Sept. 2016 (TAB B in Document ID CPSC-2006-0057-0032 in www.regulations.gov).

[30] Death data for years 2011 through 2021 are from the following report, with 5 deaths from 3 incidents in 2011 excluded because they involved stationary generators, which are outside the scope of the proposed rule: Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2022 (Document ID CPSC-2006-0057-0108 in www.regulations.gov).

generator-related CO deaths, hospital admissions, and injuries seen in EDs if generators uniformly meeting one or the other voluntary standard had been used in the incident scenarios instead of the generators that actually were involved. The results are presented in Table 3 below. This estimation assumed that the distribution of NEISS injuries was similar to the distribution of 511 fatality scenarios used in the NIST simulations. In fact, because the simulations used in the effectiveness analysis accounted for the generator operating only outside in just 2 percent (8 of the 511) of the deaths, yet this scenario accounts for 6 percent (79 out of 1332) of the deaths in CPSC's databases, unaddressed injuries from G300-compliant generators may exceed these estimates.

Table 3. Estimates of Generator-Related CO Deaths and Injuries Seen in EDs if Generators Meeting Either Voluntary Standard Had Been Involved, 2004-2021

Outcome for Operators and Collateral Occupants	Baseline vs. Standards		
	Baseline	G300	UL 2201
Fatalities	1332	183.77	0.09
Percentage of deaths averted versus baseline (BL) generators	- -	86.20%	99.99%
Survivors who are hospitalized or transferred to specialized treatment center	7307.67	1,136.54	8.85
Survivors who seek ED treatment and are treated and released	17,568.97	3,227.44	62.21
Survivors who visit doctor/clinic and are treated and released	52,781.62	9,544.73	242.20

The analysis found that under simulated conditions, generators compliant with the CO emission rate and shutoff requirements of the UL 2201 standard would avert nearly 100 percent of the 511, with three survivors requiring hospitalization, and 24 survivors seeking medical

treatment and being released. Staff's analysis found that generators compliant with the shutoff requirements of the PGMA G300 standard would avert about 87 percent of the deaths, resulting in 69 deaths, with 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released. See Tab A of Staff's SNPR Briefing Package.

E. CO Shutoff System Requirements

The foregoing analysis demonstrates that UL 2201's weighted CO emission rate limit of 150 g/h and shutoff concentrations of 150 ppmv at a rolling 10-minute rolling average or an instantaneous measurement of 400 ppmv are extremely effective in the simulated conditions where the system, including shutoffs, operates as designed. To ensure that these simulated performance requirements are effective in real-world scenarios, however, the CO shutoff system must be reliable, functional, and durable.

1. Functionality of the CO Shutoff System

The analysis of the effectiveness of the performance requirements in the voluntary standards assumed the shutoff system functioned properly and shut the generator off when the shutoff criteria in each voluntary standard were met. If the shutoff system is bypassed, damaged, or overridden such that the generator can operate without the shutoff system functioning, or functioning properly, the effectiveness of the performance requirements would be reduced. Thus, requirements to maintain the functionality of the shutoff system are included in the proposed rule.

Specifically, as discussed in section IV.B. above, PGMA G300 has requirements regarding tamper resistance in sections 3.9.1.2.1. through 3.9.1.2.4. The Commission concludes that these requirements, with modifications as specified in section VI.C.5 of this preamble, are necessary and adequate to ensure the CO shutoff system maintain functionality.

2. Self-Monitoring of CO Shutoff System

Similarly, if the system has a fault, loss of power, or the system reaches end-of-life yet the generator operates without the shutoff system functioning, the effectiveness will be reduced. Therefore, the Commission assesses that requirements for self-monitoring of the shutoff system are necessary. PGMA G300 provides requirements for self-monitoring while UL 2201 does not. PGMA G300's requirements in section 3.9.1.1 require that faults involving the CO sensing element, loss of power source for the CO shutoff system, and end of life condition, be applied one at a time to the system's circuitry while the engine is running. The engine is required to shut off after each fault or end of life is introduced. The Commission concludes that these self-monitoring requirements are necessary for ensuring proper functioning of the shutoff system. Thus, the requirements are included in the proposed rule.

3. Durability Requirements for the Shutoff System

Durable and reliable operation of the CO shutoff system also is critical for effectiveness. Section 3.9.1 and 3.9.1.4 of PGMA G300 includes requirements from UL 2034, *Single and Multiple Station Carbon Monoxide Alarms,* to address the construction and performance of the CO safety shutoff system. This standard is the leading U.S. standard for CO alarms and provides a robust set of requirements for CO alarms. CO alarms that meet the requirements of UL 2034 have demonstrated reliable operation for many years. UL 2034 provides design and performance requirements for CO alarms that cover topics related to the construction of the CO shutoff system such as gas and vapor interference, dust exposure, vibration, corrosion, and extreme temperature and humidity exposure. Additionally, section 3.9.1.4 of PGMA G300 requires that the carbon monoxide sensor used in the shutoff system have a UL mark or equivalent NRTL

mark, which is indicative that the sensor is capable of meeting the requirements for use in UL 2034 compliant systems.

UL 2201 on its own is not adequate to address the CO shutoff system because it does not prescribe requirements for the construction of the CO shutoff system. If the system does not function properly because of conditions affecting its durability and ability to reliably shut the generator off when the shutoff criteria are met, the effectiveness will be reduced below the near-100 percent level modeled in the simulation by CPSC staff and NIST. The Commission concludes that the related construction and performance requirements in section 3.9.1 and 3.9.1.4 of PGMA G300, with the modification that the shutoff criteria need to correspond to those of the proposed rule, are necessary to address the environmental conditions (gas and vapor interference, dust, vibration, corrosion, and variable temperature and humidity) that the shutoff system could be exposed to when mounted on a portable generator.

4. Test method to verify compliance with CO Shut-off Criteria

An effective test method must expose the CO safety shutoff system to CO concentrations that will initiate shutoff. The test method also must verify that the CO safety shutoff system functions properly or does not allow the generator to start when the power supply to the system is not functioning. The Commission assesses that the test method in PGMA G300 provides a reasonable foundation for a test method to reliably assess the safety shutoff system.

UL 2201 and PGMA G300 provide similar test methods for evaluating the performance of the CO safety shutoff system to a set of acceptance criteria. Both test the generator assembly in an enclosed space that is filled with exhaust emissions from the generator while an air sample is taken from above the generator to determine if the generator shuts off before the room reaches

the shutoff acceptance criteria. Tab E of Staff's SNPR Briefing Package provides a detailed description of the test methods in PGMA G300 and UL 2201.

The Commission concludes that the test method in Section 6.2.11.2 of PGMA G300 and related definitions from Section 2 of PGMA G300 are generally appropriate to evaluate the CO safety shutoff system. However, some changes to the PGMA test method and definitions in Section 2 will result in better assessment of the CO safety shutoff system and therefore further reduce the risk of death and injury associated with portable generator CO poisoning. Accordingly, the Commission is proposing to modify the test method as follows.

a) Test Room Volume and Dimensions: The Commission preliminarily assesses that it is not necessary for the room volume to be constrained to the volumes identified in PGMA G300 or UL 2201, and additional flexibility is appropriate. Currently, there are generators on the market that certify to UL 2201 and generators on the market that certify to PGMA G300; therefore, testing has been performed using both ranges of test room volumes specified in each standard. Increasing the range of volumes to 895 – 2100 ft^3 (25.34 – 59.47 m^3)—a greater range than in either test alone—encompasses the ranges specified in both standards. Accordingly, the proposed rule specifies that the test room shall be designed such that the room volume is between 895 – 2100 ft^3 (25.34 – 59.47 m^3) with a ceiling height between 8 -12 ft (2.44 - 3.66 m) and be capable of meeting the requirements for generator position.

b) Test Room Air Inlet and Outlet Specifications: PGMA G300's test method does not specify the location and dimensions of the air inlet and outlet of the test room. The Commission preliminarily assesses that specifying the location and dimensions of the air inlet and outlet is necessary because the air flow near the inlet and outlet could affect CO concentrations near the onboard sensor or the sample port for the CO analyzer. Accordingly, the proposed rule defines

the location of the air inlet and outlet by specifying their configuration based on performance. Specifically, the proposed rule requires that the configuration of the air inlet and outlet for ventilation be designed such that neither port creates a flow directly onto or near the CO analyzer sample port above the generator or the CO sensor onboard the generator that is used as part of the CO safety shutoff system.

c) Ventilation: PGMA G300 does not specify a requirement for how ventilation is induced. Requiring a fan on the air outlet will ensure that the ventilation system will not create a positive pressure within the room. A scenario with no ventilation, or 0 air changes per hour (ACH), induced by an air inlet fan can pose a safety risk to test operators because the pressure in the room may exceed the pressure outside of the room as the generator heats the space. This could result in leakage from the test room. Specifying a minimum of 0.1 ACH will create a slightly negative pressure in the room, which will assist in preventing leakage. Accordingly, the Commission is proposing to change the ventilation range from "0 – 1.0 ACH" as stated in the PGMA G300 standard to "0.1 – 1.0 ACH," to reduce the potential of gas leakage from the test room. Additionally, the Commission is requiring an exhaust fan on the air outlet to induce ventilation from the room and prescribing that no air inlet fan can be used. The proposed rule requires that the ventilation rate of the test room shall be between 0.1 – 1.0 ACH and ventilation shall be induced by a fan on the air outlet.

d) Generator Position within the Room: The Commission proposes that it is necessary to provide constraints on the position of the generator to accommodate different test room dimensions. These constraints address concerns related to airflow around the CO sensor onboard the generator and CO analyzer sampling port, as well as exhaust gas diffusion within the space. Accordingly, the proposed rule requires that the generator be positioned such that the exhaust jet

centerline is along one of the test room centerlines; the exhaust outlet on the generator be at least 6 ft (1.83 m) from the opposite wall; the outer surfaces of the generator housing or frame are at least 3 ft (0.91 m) from the walls on all other sides; and the onboard CO sensor used for the CO safety shutoff system be at least 1 ft (0.30 m) away from any obstruction.

e) CO Measurement Location: PGMA G300 specifies that the CO sample port, which is used in conjunction with the CO analyzer to measure the concentration of CO above the generator, be placed 1 to 2 inches above the approximate center of the generator's top surface. CPSC staff has assessed that this location is too close to the generator and the sample may be affected by low flow/mixing conditions present near the surfaces of the generator. Accordingly, the Commission is proposing to increase the height of the CO sample port above the generator. The proposed rule requires that the CO sample port connected to the CO analyzer for determining room concentration shall be placed 1 ft (0.30 m) above the center point of the top of the generator.

f) Load Bank and Power Meter Specifications: The load bank is used to apply an electrical load on the generator. Applying an electrical load to the generator will simulate the conditions of a generator under typical use. PGMA G300 specifies a range of requirements for a voltmeter, wattmeter, ammeter, frequency sensor, and load bank. These requirements include tolerances for measurement of true root mean square (RMS) voltage, wattage, and current. The Commission believes that these requirements are unnecessary and an exact load or associated emission rate is not required to test the CO safety shutoff system. Instead, the proposed rule reflects the Commission's preliminary assessment that a resistive load bank and power meter with an accuracy of 5 percent is sufficient to achieve the goals of testing.

5. PGMA G300 Shutoff Notification Requirements

PGMA G300 includes several requirements specific to notifying consumers if the generator automatically shuts off in response to detecting sufficiently high levels of CO in its vicinity. In contrast, UL 2201 lacks such notification requirements, even though it, too, includes CO shutoff performance requirements. The Commission considers CO shutoff notification requirements to be reasonably necessary for any portable generator standard that includes CO shutoff performance requirements.

The PGMA G300 shutoff "notification" requirements consist of two main parts: (1) a "red indication" (section 3.9.1.3.1) and (2) associated product markings. However, the voluntary standard does not specify many of the qualities of the "red indication." For example, the G300 standard permits the indication to be "blinking, with a maximum period of 2 seconds" (§ 3.9.1.3.1), but this is not required and there is no requirement for the indication to be illuminated. However, the standard does require that the indication:

- Be able to be viewed by a user with normal vision, under expected visibility conditions (§ 3.9.1.3);
- Be "prominent and conspicuous … in a readily visible location" that is "not easily obscured during use" (§ 3.9.1.3);
- Contrast with the background color (§ 3.9.1.3);
- "[R]emain" for at least 5 minutes after shutoff occurs, or until the generator is restarted (§ 3.9.1.3.1);
- Not be present if the generator is restarted (§ 3.9.1.3.1); and
- Be labeled or marked with an indication of its function and the required action to activate its function (§ 4.1.1.1.3).

As noted, the PGMA G300 standard also requires product markings that relate to the notification system. These markings include the following, which must be "in a readily visible location" (§ 7.2.2.4):

- An identification of the hazard associated with tampering with the CO shutoff system;
- An identification and description of the CO shutoff system notifications that are "in close proximity to each CO shutoff notification";
- An identification of the engine exhaust, including instructions to direct the exhaust away from occupied structures;
- A label, "in close proximity to the notification," with the content as shown in Tab F, Figure 26 of the Staff's SNPR Briefing Package, or as "Figure 5 – User instruction label" in PGMA G300.

a) Notification Indicator Requirements

The Commission considers the notification requirements in PGMA G300 to be a reasonable foundation for similar requirements in the proposed rule. However, the Commission preliminarily considers the "indication" requirements specified in PGMA G300 to be insufficient for the proposed rule, for the reasons outlined below, and concludes that the following revisions are reasonably necessary to further reduce the risk of injury or death associated with portable generators. Tab F of the Staff's SNPR Briefing Package provides a detailed discussion of the rationale for these changes.

- *Require that the "red indication" be illuminated*. PGMA G300 permits, but does not require, the "red indication" to be "blinking" and does not require the indication to be illuminated. Human engineering and human factors guidelines for displays most commonly recommend illuminated (also known as "transilluminated") indicators,

generally taking the form of simple indicator lights or legend lights for detectability. Red indicator lights typically are used to alert operators that a system is inoperative, that corrective action is needed to restore operation, or that there has been a malfunction. Thus, the proposed rule requires that the red light be illuminated.

- *Require the indicator to meet visibility and conspicuousness requirements for a consumer positioned in front of the startup controls*. PGMA G300 specifies that the indication must be prominent, conspicuous, and in a "readily visible location" that is "not easily obscured during use." The Commission generally agrees with these requirements but believes additional specificity about where around the generator one would make these assessments would be beneficial. Positioning the indicator, and associated label, so they are prominent, conspicuous, and not obscured when viewed from the startup controls increases the likelihood that consumers will notice the indicator and follow the recommended action before restarting. Accordingly, the proposed rule specifies such placement.
- *Require the red indicator to be at least 0.4 inches diameter in size*. PGMA G300 does not include any size requirements for the indication, meaning an indication of any size would be permitted. Based on the analysis in Tab F of Staff's SNPR Briefing Package, the Commission considers a minimum indicator size of 0.4 inches, or 10 mm, diameter to be a reasonable requirement.
- *Specify that the indicator, if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark durations*. Although the Commission does not consider requiring a flashing light to be necessary, if a manufacturer chooses to use a flashing light, then it should be no less visible than a steady light. The proposed rule therefore

specifies that the indicator, if flashing, must be at a more detectable flash rate, with equal light and dark periods.

In addition to the proposed requirements above, the Commission seeks public comments on the following issues:

- *Minimum indicator brightness or luminance*. PGMA G300 does not specify the brightness of the indication. The Commission seeks comments regarding whether a minimum luminance requirement is needed for the notification indicator, and if so, what would be an appropriate requirement.
- *Minimum indicator duration, if not restarted.* PGMA G300 specifies that the indicator must "remain" for at least 5 minutes after shutoff occurs, or until the portable generator is restarted. Although the Commission agrees that the indicator should not remain illuminated after the generator has restarted, we question whether 5 minutes is an appropriate minimum duration for the indicator to remain. A more appropriate requirement would base the duration on the amount of time needed before CO concentrations in the environment have dropped to a reasonably safe level. The Commission is uncertain whether 5 minutes achieves this goal, particularly given the range of possible environmental conditions. Therefore, the Commission seeks public comment on this issue.

b.) Labeling for the CO Shutoff System

The Commission considers the notification-related marking and labeling requirements in PGMA G300 to be a reasonable basis for similar requirements in the proposed rule for portable generators. For example, the Commission agrees with the PGMA G300 requirements for portable generators to be marked with the location of the engine exhaust and instructions to

direct the exhaust away from occupied structures, and the requirement is worded in a way that allows for substantial flexibility regarding how to communicate these two issues. The Commission also agrees with the PGMA G300 requirement for portable generators to be marked for the "hazard due to tampering with" the CO shutoff system and to identify and describe the CO shutoff system notifications "in close proximity to each CO shutoff notification."

However, for the reasons given below and explained more fully in Tab F of the Staff's SNPR Briefing Package, the Commission concludes that the PGMA G300 requirements specific to the label are insufficient and the following revisions are reasonably necessary to adequately reduce the risk of injury or death associated with CO emissions from portable generators.

- *Require the label to be located no more than 0.25 inches from the notification indicator, or for the indicator to be incorporated into the label*. PGMA G300 specifies that the notification label must be "in a readily visible location … in close proximity to the notification" (§ 7.2.2.4); however, it is unclear how "close" the label must be to the notification indicator to meet the requirement. Given that the label is intended to communicate to consumers what must be done when the CO shutoff system activates, and for clarity of administration, the Commission is proposing that the label be located where consumers are likely to be looking when they are notified that the generator has shut off due to elevated CO levels.
- *State explicitly why the generator shutoff*. The label specified in PGMA G300 instructs consumers what to do in response to the generator shutting off but does not explain why the generator shut off. Consumers should not be required to infer why they should move the generator, and an explicit description of the potential hazard associated with not performing the recommended action is likely to increase consumers' motivation to

comply. Thus, the Commission proposes that the phrase "YOU MUST" be replaced with "HIGH LEVELS OF CARBON MONOXIDE." Figure 27 in Tab F of Staff's SNPR Briefing Package provides an illustration of how this change may be accomplished.

- *Use sentence capitalization rather than all-uppercase text, except when highlighting key phrases*. Words in all-uppercase text are less legible than words in lowercase text, and all-uppercase text is less readable than mixed-case text (*i.e.*, both uppercase and lowercase letters) particularly under low-light conditions or for longer strings of text.
- *Clarify that the generator must be moved before restarting the generator, and reduce redundancy with the mandatory DANGER label*. This change advances the primary function of the notification label, *i.e.,* to explain why the generator shut off, and what actions the consumer should take before restarting the generator. The label is not intended to reiterate the information that is already present on the mandatory DANGER label. The Commission is also proposing that consumers be told upfront to move the generator to a "more open" outdoor area "before restarting," to emphasize that moving the generator is directly relevant to restarting the generator, and to make it clear that even if consumers believed that the generator was already in an open area, the generator must be moved to a *more* open area.
- *Add sizing requirements for the label*. PGMA G300 currently does not include any requirements for the size of the label, suggesting that a label of any size, even one too small to be reasonably legible or readable, would be permitted. In the label presented in the PGMA G300 standard document itself, the header text measures approximately 0.12 inches in height and the remaining text is printed in text whose uppercase letters measure

about 0.10 inches in height. The Commission considers these to be reasonable dimensions and the proposed rule specifies these as the minimum text size for the label.

VI. Description of the Proposed Rule

This section summarizes the provisions of the proposed rule to improve the safety of portable generators.

A. Description of Proposed Section 1241.1 – Scope, application, and effective Date

Proposed section 1241.1 provides that new part 1241 establishes a consumer product safety standard for portable generators to address the acute CO poisoning hazard associated with portable generators.

Proposed section 1241.1 provides that, for purposes of the rule, portable generators include single-phase, 300 V or lower, 60-hertz generators that are provided with receptacle outlets for alternating current (AC) output circuits and intended to be moved by the consumer, although not necessarily with wheels. The engines in these portable generators are small, nonroad spark-ignition engines, based on the EPA's engine classifications per 40 CFR 1054.801, and are fueled by gasoline, LPG, or natural gas. Proposed section 1241.1 provides that, for purposes of this rule, portable generators do not include:

(1) Permanent stationary generators;

(2) 50-hertz generators;

(3) Marine generators;

(4) Generators solely intended to be pulled by, or mounted on vehicles;

(5) Generators permanently mounted in recreational vehicles or motor homes;

(6) Generators powered by compression-ignition engines fueled by diesel;

(7) Industrial-type generators intended solely for connection to a temporary circuit breaker panel at a jobsite.

Proposed section 1241.1 provides that the rule would apply to generators manufactured after 180 days following publication of the final rule in the *Federal Register.*

B. Description of Proposed Section 1241.2 – Definitions

Proposed section 1241.2 provides definitions that apply for purposes of part 1241, in addition to the definitions in section 3 of the CPSA (15 U.S.C. 2051). These definitions include: units of measurement; maximum available observed wattage; air change rate; CO analyzer; engine; ordinary tools; portable generator system for controlling CO exposure; rated wattage; CO shutoff system, and test room. Many of these definitions define terms that are used in the incorporated voluntary standards.

C. Description of Proposed Section 1241.3 – Requirements.

Proposed section 1241.3 sets forth the requirements for portable generators.

1. CO Emission Rate Requirements (§ 1241.3(a))

The Commission proposes to require that, as specified in sections 5.2.8 and 5.3.3 of UL 2201, portable generators shall emit no more than a weighted CO rate of 150 g/h, when tested to one of two methods specified in sections 5.2.2 and 5.3.2 of UL 2201. The first method measures the CO emission rate with the engine installed in the generator assembly, in the configuration as purchased by the consumer. The second method measures the CO emission rate of a standalone engine mounted on a dynamometer.

2. CO Shutoff Construction Requirements. (§1241.3(b))

Section 3.9.1 of PGMA G300 prescribes concentrations required to be achieved in the test chamber for purposes of determining activation to the CO shutoff requirements. The

Commission proposes to require that portable generators meet section 3.9.1 of PGMA G300, with changes to the concentrations to align the concentrations required to be achieved in the test chamber with the shutoff concentration requirements in UL 2201. Testing to these modified concentrations ensures that the sensor is tested to the full range of concentrations within the bounds of the shutoff requirements in UL 2201.

3. Shutoff Requirements (§1241.3(c) and (d))

The Commission proposes to require that portable generators meet the shutoff levels in UL 2201, specifically, CO concentrations of 400 ppm instantaneous or 150 ppm for a 10-minute rolling average, measured above the generator during compliance testing, in place of the concentrations in section 6.2.11.1 of PGMA G300. The Commission proposes to require that the portable generator be tested in accordance with section 6.2.11.2 of PGMA G300, using the proposed definition of "test room" in section 1241.2 for purposes of the test.

4. Self-Monitoring System (§1241.3(e))

The Commission proposes requirements for self-monitoring of the portable generator. Section 1241.3(e) requires that, pursuant to section 3.9.1.1 of PGMA G300, faults indicative of a fault with the CO sensing element, loss of power source for the CO shutoff system, and end-of-life condition, be applied one at a time to the system's circuitry while the engine is running. The engine is required to shut off after each fault or end of life is introduced.

5. Tamper Resistance (§1241.3(f))

Section 1241.3(f) proposes requirements for tamper resistance for a portable generator system for controlling exposures. The system is considered tamper resistant when any part that is shorted, disconnected, or removed to disable the operation of the system prevents the engine from running. In addition, all parts, including wiring, that affect proper operation of the portable

generator system for controlling CO exposure, must be (a) permanently sealed or (b) not normally accessible by hand or with ordinary tools. Under section 1241.3(f)(1), it is permissible for different parts of the portable generator system for controlling CO exposure to meet either option (a) or (b), provided all of the different parts meet at least one of these two options.

In addition, section 1241(f)(2) would require that, pursuant to PGMA G300, the construction of the portable generator must minimize the risk of intentional blockage of the portable generator's system for controlling CO exposure and minimize the risk of incidental damage to that system. The portable generator system for controlling exposure is not permitted to incorporate any type of override function or feature.

6. Notification (§ 1241.3(g))

Section 1241.3(g) includes CO shutoff notification requirements. The proposed rule requires that the portable generator system for controlling CO exposure include a prominent and conspicuous notification in a readily visible location to a consumer who is positioned in front of the start-up controls. The portable generator system for controlling CO exposure must provide a notification after a CO shutoff event. The notification must be at least 0.4 inches (10mm) in diameter, illuminated and, if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark durations. Section 1241.3(g) requires a non-red system fault event notification if an end-of-life condition or a system electrically detectable fault is present, except for loss of the power source for the portable generator system for controlling CO exposure.

7. Carbon Monoxide Sensor (§ 1241.3(h))

The Commission proposes to require that a portable generator system for controlling exposure contain a carbon monoxide sensing element bearing the UL recognized Component Mark or an equivalent NRTL component mark.

8. Shut-Down Safety (§ 1241.3(i))

As specified in section 4.1.1.3 of PGMA G300-2018, the Commission proposes to require that portable generators be equipped with a means for shut-down that requires only one action and overrides all run commands. Additionally, as specified in PGMA G300-2018, 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 that requires use of a tool, and all shut down mechanisms are to be labeled or marked with an indication of their function and the required action to activate the function.

9. Marking, Labeling, and Instructional Requirements (§ 1241.3(j))

Section 1241.3(j) of the proposed rule incorporates the requirements pertaining to the operator's manual, operating instructions, and warnings from section 8 of PGMA G300-2018. The Commission proposes to include Figure 5 from PGMA G300-2018 (see Tab F of Staff NPR Briefing Package) with the following changes: the label is to be located not more than 0.25 inches from the notification indicator, or the indicator is to be incorporated into the label; the header must read "AUTOMATIC SHUTOFF – HIGH LEVELS OF CARBON MONOXIDE"; use sentence capitalization rather than all-uppercase text in the message panels, except when highlighting key phrases; revise the language to clarify that the generator must be moved before restarting the generator, and to reduce redundancy with the content of the mandatory DANGER label; the size height of the text in the header must be at least 0.12 inches, and all other text in the label must be sized so the height of its uppercase letters measure at least 0.1 inches.

Table 4 summarizes the performance and labeling requirements of the proposed rule and provides a comparison with the corresponding requirements in PGMA G300 and UL 2201.

Table 4. Requirements of the Proposed Rule versus Voluntary Standards

Requirement	PGMA G300	UL 2201	Proposed Rule
Limit weighted CO emissions rate of portable generator to a maximum of 150 g/h, including test methods for verifying compliance		✓	✓
			Same as UL 2201
Require the generator to shut off before the concentration measured above the generator exceeds a threshold for either an instantaneous reading or 10-minute rolling average	✓	✓	✓
	800 ppmv instantaneous & 400 ppmv over 10 minute average	*400 ppmv instantaneous & 150 ppmv over 10 minute average*	*Same concentrations as UL 2201*
Test Method for Verifying Compliance with CO shutoff requirement	✓	✓	✓
			PGMA G300 with modifications
Sensor/Shutoff System - Maintaining functionality	✓		✓
			PGMA G300 with modifications
Sensor/Shutoff System - Self-monitoring	✓		✓
			Same as PGMA G300
Sensor/Shutoff System - Durability & Reliability	✓		✓
			Same as PGMA G300
Notification, Markings, and Labeling	✓		✓
			PGMA G300 with modifications

D. Description of Proposed Section 1241.4 – Prohibited Stockpiling

Pursuant to section 9(g)(2) of the CPSA, 15 U.S.C. 2058(g)(2), the proposed rule would prohibit a manufacturer from "stockpiling" or substantially increasing the manufacture or importation of noncompliant portable generators between the promulgation of the final rule and the effective date. The provision, which is explained more fully in Tab B of Staff's SNPR

Briefing Package, would prohibit the manufacture or importation of noncompliant products at a rate that is greater than 120 percent at which the firm manufactured and/or imported portable generators during the base period. The base period is the average monthly manufacture or import volume for any continuous 180-day period within the last 12 months immediately preceding the month of promulgation of the final rule.

We propose the atypical figure of 120 percent to provide extra flexibility, because portable generator sales are correlated to extreme weather events. Those events can cause supply shortages that are inconvenient and potentially life-threatening for consumers if generators are not available. For the same reason, we propose using average manufacture or import volume over 180 days, rather than monthly median volume, to calculate the base period. Average volume over the longer period provides a more accurate baseline where the distribution of monthly production is significantly skewed or manufacturers use seasonal production. The Commission seeks comment on these proposals.

E. Proposed Findings – Section 1241.5

The findings required by section 9 of the CPSA are discussed throughout this preamble and set forth in section 1241.5 of the proposed rule.

VII. Preliminary Regulatory Analysis

Pursuant to section 9(c) of the CPSA, publication of a proposed rule must include a preliminary regulatory analysis containing:

- A preliminary description of the potential benefits and potential costs of the proposed rule, including any benefits or costs that cannot be quantified in monetary terms, and an identification of those likely to receive the benefits and bear the costs.

- A discussion of why a relevant voluntary safety standard would not eliminate or adequately reduce the risk of injury addressed by the proposed rule.
- A description of any reasonable alternatives to the proposed rule, together with a summary description of their potential costs and benefits and why such alternatives should not be published as a proposed rule.

This preamble contains a summary of the preliminary regulatory analysis for the proposed rule. Tab B of Staff's SNPR Briefing Package contains a detailed analysis.

A. Market Information

1. The Product

Portable generators have historically been the leading product among all engine-driven tools (EDTs) to cause non-fire CO poisoning deaths and injuries to consumers, accounting for over 90 percent of the 900 reported fatalities associated with all EDTs during the period 2011 to 2021, and 88 percent of the 710 EDT incidents that occurred in this period. The pattern of deaths and injuries has not subsided over time. While data collection is ongoing, the number of CO deaths caused by portable generators in year 2020 is likely to exceed the highest number of annual deaths (103) that was previously reported, in 2005.

The expected useful life of portable generators is largely a function of engine size, loads placed upon the unit, hours of use, and appropriate maintenance and storage. Staff's evaluation of data on historical sales in relation to surveys of product ownership suggests an expected useful product life of 11 years.

New series of portable generator models are introduced every year. Staff estimates that the average shelf life (period when a particular model is on the market) for a specific model is 12

years. Staff assumes the market has reached a steady state in the number of models available for sale. Under this assumption, firms introduce new models to essentially replace retiring models. Staff collected retail prices of 108 portable generators of various sizes from top selling manufacturers. The weighted average price across different sizes of portable generators from that sample of models is $1,000.

2. Current Market Trends for Portable Generators

Staff identified 110 manufacturers of portable generators sold in the United States in 2021. The largest 10 firms by volume sold accounted for roughly 70 percent of sales. Top sellers fluctuate yearly, but a majority of the top 10 firms each year are U.S. based companies. In recent years, portable generators manufactured in the U.S. represented between 55 and 60 percent of all portable generator sales.

Staff used multiple sources to estimate portable generator sales in 2021 of 2.1 million units, which results in total revenue for the portable generator industry of $2.1 billion. Staff estimated the total number of portable generators in use to be 21.46 million in 2021. Staff estimated the number of individual models available for sale each year from the Power Systems Research sales dataset; in 2021, there were a total of 1,355 models for sale in the U.S. Staff also produced estimates of the number of new portable generator models introduced each year, as well as the total number of models for sale in any given year within the time horizon of the analysis. Based on staff's estimations, there was a net gain of six additional models available for sale in 2021. See Tab B of Staff's SNPR Briefing Package.

3. Future Market Size for Portable Generators

Consumer demand for portable generators fluctuates annually with power outages, which are generally caused by hurricanes and other storms along the Gulf and Atlantic coasts, or by

winter storms in other areas. Power outages or the presence of storms create periods of increased demand for portable generators that tend to be followed by periods of reduced demand, because the purchases in the prior period saturated a portion of the market demand. This cyclicality of demand can impact the industry, whose inventories and orders vary along the same continuum.

In spite of this cyclicality of demand, staff projected future sales at a rate of growth that is unrelated to the occurrence of specific weather events. Staff postulates that the sales of portable generators are linked in the long run to the growth in the number of households in the U.S.; however, due to the increased frequency of weather events in the last decades and the predictions of more frequent and severe storms in the future,[36] staff expects demand for portable generator to grow more quickly than the expected growth in the number of households over time. See TAB B of Staff's SNPR Briefing Package for additional information regarding this analysis.

Staff estimated the rate of growth of portable generator sales for the 30-year period of analysis, as displayed in Table 5.

Table 5. Growth Rate of Portable Generator Sales, 2022-2053

Growth Rates in Sales	Population Growth Rates	Household Growth: 1.26 × Population Growth	Sales Growth: 2.13 × Household Growth
2022 - 2030	0.60%	0.75%	1.60%
2030 - 2040	0.46%	0.58%	1.24%
2040 - 2050	0.37%	0.46%	0.98%
2050 - 2053	0.29%	0.37%	0.78%

Figure 2 displays projected portable generator sales from 2024 through 2053 in the absence of the proposed rule and distinguishes their compliance with either of the voluntary

[36] See the U.S. Environmental Protection Agency's Climate Change Indicators at Climate Change Indicators: Weather and Climate | US EPA.

standards: PGMA G300 or UL 2201.[37] Based on information provided by manufacturers and in market research, staff estimates a 30 percent compliance rate with PGMA G300's sensor and shutoff requirements. One-sixth of those PGMA-compliant units (or 5 percent of the total) are estimated to also be compliant with the emissions requirements of UL 2201. Staff assumed that in the absence of the proposed rule those compliance rates would continue into the future.

Figure 2: Portable Generator Forecast of Sales by Compliance Status, 2024-2053

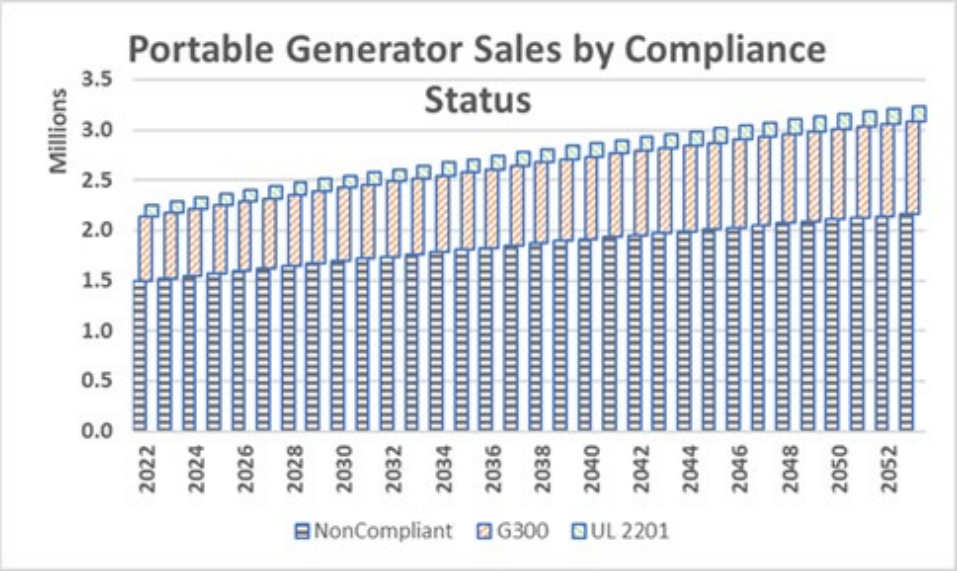


Figure 2 shows that under these assumptions the number of portable generators sold per year is expected to reach three million units by 2045, and close to 3.25 million units by the end of the period of analysis.

Portable generators have an expected product life of 11 years. Staff used forecasted sales and the expected product life with a statistical distribution to estimate the likelihood of their continued use by consumers, and as a result produced an estimate of the total number of portable

[37] Staff assumed that if a generator complies with the emission requirements included in UL 2201, it also complies with the sensor / shutoff requirements from PGMA G300; therefore, some portable generators comply with the sensor/shutoff requirements only, while others would comply with both sensor/shutoff and emission requirements.

generators in use every year during the 30-year period of the analysis. Figure 3 shows the estimated number of products in use without the implementation of the proposed rule.

Figure 3: Forecast of Portable Generators in Use by Compliance Status, 2022-2053

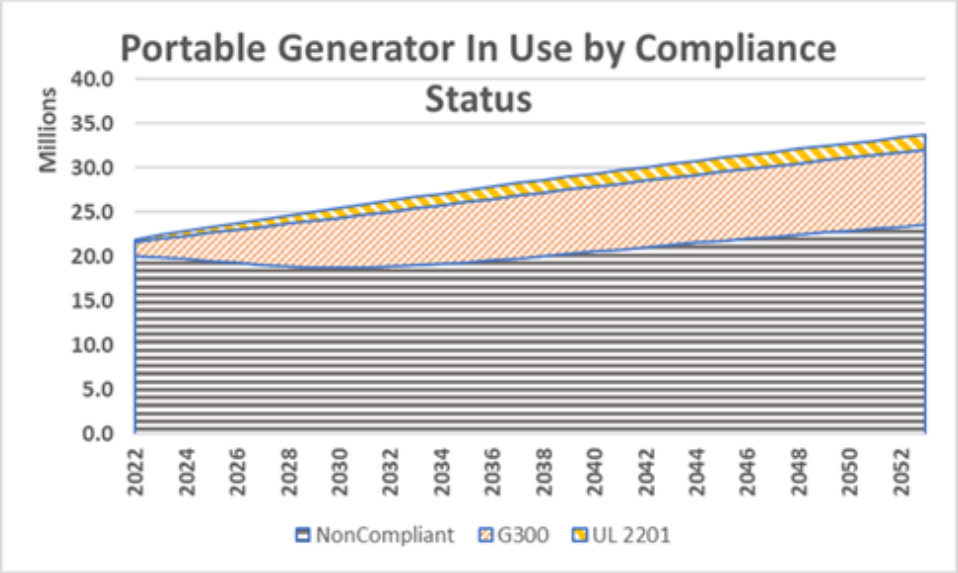


Figure 3 shows that under staff's assumptions the number of portable generators that would be in use without the proposed rule are roughly 22 million in 2022 and expected to grow by more than 50 percent over the next 30 years. By 2053, staff estimates that the total number of portable generators in use will reach nearly 34 million. The share of noncompliant portable generators decreases over time, from 91.4 percent in 2022, to 70 percent by 2053, matching the share of noncompliant portable generators continuing to be sold on a year-by-year basis, as older noncompliant units are retired.

Staff also estimated the number of models available for sale each year during the period of analysis, as well as the number of new models introduced each year. Staff concluded that the number of models has essentially reached a steady state and that the number of new models introduced each year replaces models being retired at a rate of 8.3 percent per year. Staff

estimates that approximately 113 or 114 new portable generator models are introduced each year. The number of models available for sale will reach 1,414 in 2023, and only 1,424 in 2053.

B. Preliminary Regulatory Analysis: Cost Analysis

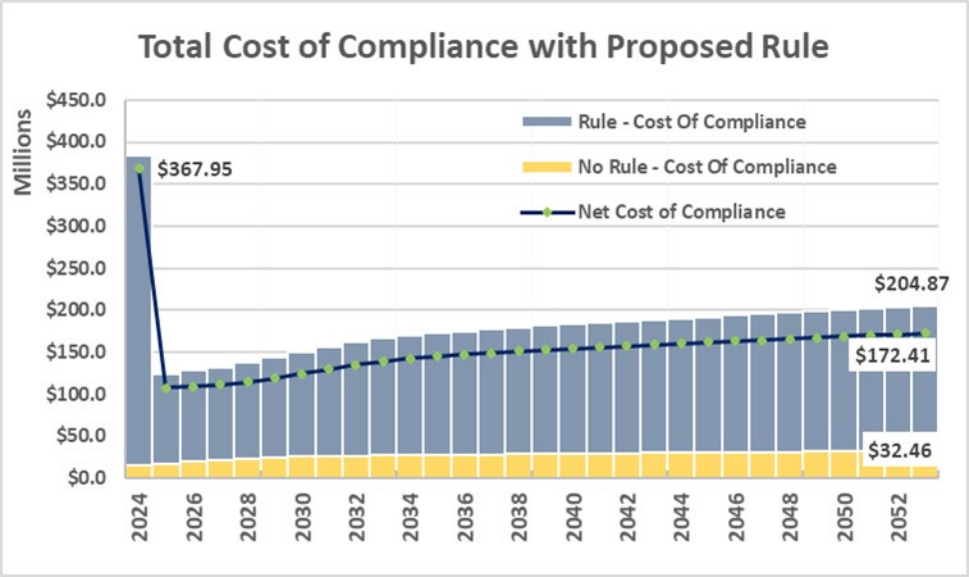
The proposed rule would impose the following costs: one-time conversion costs of redesigning existing portable generator models and modifying manufacturing operations for the development of portable generators with reduced emissions and with CO sensors/shutoff systems; increased variable costs of producing portable generators with reduced CO emission rates and CO sensors with shutoff capabilities; recurrent testing cost to validate compliance of each new model with the proposed standard; sensor replacement costs to consumers for the substitution of failed CO sensors or CO sensors that have reached end of life; and deadweight loss[38] caused by price increases resulting from increased manufacturing costs.

1. 30-Year Total Cost of the Proposed Rule

Staff added up all cost categories to determine the total cost of the proposed rule over the 30-year study period, as show in Figure 4.

[38] Deadweight loss is the net loss to consumers and producers of the value generated from lost transactions that would have occurred in the absence of the new regulation.

Figure 4: Total Costs over the 30-Year Study Period



Over the 30 years, the net cost of implementing the proposed rule add up to $4.63 billion undiscounted, $2.92 billion discounted at 3 percent, and $1.78 billion discounted at 7 percent.

2. Annualized and Per Unit Cost of the Proposed Rule

This section converts the aggregate costs over the 30-year study period into annualized and per-unit outputs. An annualized output converts the aggregate costs over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the costs among different rules or policy alternatives that may have different timelines, or those that have similar timelines but costs for one are front-loaded while the other's maybe backloaded. A per-product metric expresses the costs from the rule in one unit of product. This metric is helpful when assessing the impact in marginal terms—for example, comparing costs to an increase in retail price.

Table 6 summarizes the net cost of the proposed rule in annualized terms under staff's assumptions:

Table 6. Annualized Cost of the Proposed Rule

Cost Categories	Annualized Cost ($M)		
	Undiscounted	3% Discount	7% Discount
Manufacturing Cost	$127.31	$120.86	$113.20
Model Redesign and Testing	$6.39	$10.33	$16.27
CO Sensor Replacement	$19.83	$16.90	$13.30
Deadweight Loss	$0.90	$0.85	$0.80
Total Cost	**$154.43**	**$148.94**	**$143.56**

Table 7 summarizes these net costs in per unit terms:

Table 7. Per Unit Cost of the Proposed Rule

Cost Per Product	Cost per Product ($)		
	Undiscounted	3% Discount	7% Discount
Manufacturing Cost	$50.83	$31.53	$18.69
Model Redesign and Testing	$2.55	$2.69	$2.69
CO Sensor Replacement	$7.92	$4.41	$2.20
Deadweight Loss	$0.36	$0.22	$0.13
Total Cost	**$61.66**	**$38.85**	**$23.71**

C. Preliminary Regulatory Analysis: Benefits Analysis

To estimate benefits from the proposed rule, staff estimated the number of injuries from casualties reported through the NEISS - a national probability sample of U.S. hospital emergency departments (ED) - and counted the number of deaths entered in the Consumer Product Safety Risk Management System (CPSRMS), a database of consumer incident reports. In addition to these two databases, staff used estimates generated by the CPSC's Injury Cost Model (ICM). See Section IV of this preamble and Tab A of Staff's SNPR Briefing Package for further description.

Staff then used death counts and the ICM national estimates of the number of injuries to forecast the number of expected deaths and injuries for a 30-year study period. To produce a

forecast, staff assumed the incident rates by type of injury per million portable generators would remain at the same levels experienced during the period 2004 through 2021. Staff then used the expected effectiveness of the proposed rule in preventing deaths and injuries to estimate the number of prevented fatalities and injuries, which were then monetized using the value of statistical life (VSL) for deaths and ICM cost estimates for injuries. Over 30 years, the Commission estimates the rule would prevent 2,148 deaths (nearly 72 deaths per year) and 126,377 injuries (roughly 4,213 injuries per year).

Staff then converted the aggregate benefits over the 30-year study period into annualized and per unit outputs. For detailed information on this analysis, see Tab B of Staff's SNPR Briefing Package.

Table 8 summarizes the benefits of the proposed rule in annualized terms.

Table 8. Annualized Benefits of the Proposed Rule

Prevented Casualties	Annualized Benefits ($M)		
	Undiscounted	3% Discount	7% Discount
Deaths	$977.85	$848.90	$695.08
Injuries	$224.24	$197.10	$164.05
Total Benefits	**$1,202.09**	**$1,046.00**	**$859.13**

Table 9 summarizes the cost of the proposed rule in per unit terms.

Table 9. Per Unit Benefits of the Proposed Rule

Prevented Casualties	Per Unit Benefits ($)		
	Undiscounted	3% Discount	7% Discount
Deaths	$390.39	$221.43	$114.78
Injuries	$89.52	$51.41	$27.09

Total Benefits	$479.92	$272.84	$141.88

Based on these estimates, the benefits of the rule outweigh the costs by a factor of 7.02, when discounted at 3 percent. Table 10 displays annualized metrics for both the benefits and costs of the proposed rule. The benefits of the proposed rule far exceed the estimated costs. The Commission calculates net benefits, discounted at 3 percent, to be $1.046 billion in benefits less $148.94 million in costs, or $897.06 million on an annualized basis.

Table 10. Annualized Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$1,202.09	$1,046.00	$859.13
Costs	$154.43	$148.94	$143.56
Net Benefits (Benefits – Costs)	**$1,047.65**	**$897.06**	**$715.57**
B/C Ratio	**7.78**	**7.02**	**5.98**

3. Sensitivity Analysis

Even in the absence of the rule, there are a number of portable generators for sale in the market that currently comply with PGMA G300, and a smaller number of generators that comply with UL 2201. Based on information provided by large U.S. manufacturers about their existing models and plans, which was then supported by an analysis of portable generators for sale online, CPSC staff estimated that the current level of compliance with the sensor and shutoff requirement (*i.e.,* PGMA G300) is at 30 percent, while compliance with both requirements (*i.e.,* UL 2201) is at 5 percent of total annual sales. The Commission assumes that in the absence of the proposed rule, those compliance rates would stay constant in future years.

Because voluntary compliance with either standard can potentially reduce the costs and benefits of the proposed rule, and because PGMA has suggested that staff's estimate of 30 percent compliance with PGMA G300 is too low, the Commission provides a sensitivity analysis to assess the significance of a higher level of compliance in the baseline scenario (*i.e.*, no proposed rule implemented) on the net benefits of the proposed rule. For this analysis, CPSC doubles the assumed level of compliance with PGMA G300 to 60 percent, while maintaining the level of compliance with UL 2201 at 5 percent.

Table 11 presents the annualized and per product benefits of the main analysis and the corresponding metrics for this sensitivity analysis. A higher compliance with the PGMA G300 voluntary standard reduces the annualized benefits from the proposed the rule from $1,046 million to $678.17 million and reduces the benefits per product from $272.84 to $176.72. Estimated benefits would still exceed estimated costs by a ratio of more than five to one.

Table 11: Sensitivity Analysis – Change in Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Main Analysis	Sensitivity at 60 percent	Main Analysis	Sensitivity at 60 percent
Benefits	$1,046.00	$678.17	$272.84	$176.72
Costs	$148.94	$132.31	$38.85	$34.48
Net Benefits (Benefits – Costs)	**$897.06**	**$545.86**	**$233.99**	**$142.24**
B/C Ratio	**7.02**	**5.13**	**7.02**	**5.13**

Because there is significant uncertainty about the levels of current compliance with the sensor/shutoff and emission requirements in the voluntary standards, including PGMA's recent assertion that over 68% of the PGMA member company generators comply with the CO shutoff requirement, the Commission has conducted additional sensitivity analyses to produce a more comprehensive assessment of the benefits and costs of the proposed rule. The levels of assumed

compliance used for this purpose may either overstate or understate actual compliance with particular requirements of the standards, but they are useful to illustrate the direction of the benefit-cost analysis under these threshold situations.

With this objective in mind, Commission staff conducted a sensitivity analysis that increased compliance with the sensor/shutoff requirement (*i.e.,* PGMA G300) from the estimated 30 percent used in the main analysis to 80 percent, while maintaining compliance with the UL 2201 emissions requirement at 5 percent of total annual sales. As shown in Table 12, even with such high compliance rate with the sensor/shutoff requirement of the PGMA G300 in the baseline, the implementation of the rule generates annualized net benefits of $311.4 million due to reduced deaths and injuries. The benefits are less than half the benefits in the main analysis, and the cost of implementation are also lower. However, this modeled situation again produces benefits that significantly exceed the costs, with every $1 in costs generating $3.56 in benefits.

Table 12. Sensitivity Analysis at 80 Percent Compliance Rate with Sensor/Shutoff Requirement – Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Main Analysis	Sensitivity at 80 percent	Main Analysis	Sensitivity at 80 percent
Benefits	$1,046.00	$432.95	$272.84	$112.75
Costs	$148.94	$121.55	$38.85	$31.65
Net Benefits (Benefits – Costs)	**$897.06**	**$311.40**	**$233.99**	**$81.09**
B/C Ratio	**7.02**	**3.56**	**7.02**	**3.56**

Commission staff also conducted a sensitivity analysis that changed compliance with the emissions requirement of UL 2201 from the estimated 5 percent used in the main analysis to 1 and 10 percent, while maintaining compliance with the sensor/shutoff requirement of PGMA G300 at 30 percent of total annual sales. Table 13 displays annualized benefits, costs, net

benefits and benefit-cost ratios of the proposed rule under these assumptions. These compliance rates have small impacts on the annualized net benefits compared to the baseline, with a change of less than $5 million in each case. Benefits still exceed costs by a factor of almost seven, with every $1 in costs generating $6.87 in benefits at the 1 percent compliance rate, and $7.20 at the 10 percent compliance rate.

Table 13. Sensitivity Analysis at 1 and 10 Percent Compliance Rate with the Emissions Requirement – Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Sensitivity at 1 percent	Sensitivity at 10 percent	Sensitivity at 1 percent	Sensitivity at 10 percent
Benefits	$1,053.90	$1,036.12	$263.77	$285.34
Costs	$153.49	$143.92	$38.41	$39.64
Net Benefits (Benefits – Costs)	**$900.42**	**$892.20**	**$225.36**	**$245.70**
B/C Ratio	**6.87**	**7.20**	**6.87**	**7.20**

4. Unquantified Benefits and Costs

The benefit-cost analyses above estimate the cost to consumers and producers pushed out of the market by calculating deadweight loss. However, Commission staff was unable to quantify the increased utility to consumers from having safer portable generators. This utility is derived from the sense of additional safety or reduction in anxiety when operating the product knowing that the hazard has been mitigated. This benefit is in addition to the reduced deaths and injuries quantified in this analysis and would indicate that the benefits estimated in this analysis are likely an underestimate of all benefits accrued to consumers. See Tab B of Staff's SNPR Briefing Package for further discussion of the assessment of intangible benefits.

The Commission was also unable to quantify precisely the benefits of reducing injuries from the increased level of safety provided by the proposed rule's CO emissions requirement

with respect to the outdoor operation of G300-compliant portable generators.[45] Although the hazard pattern of injuries is largely unknown because of minimal narratives from NEISS records, the Commission believes it is reasonable to assume that at least some of the injuries—like some of the reported deaths for which scenarios are known—were caused by portable generators operated outdoors.

The Commission assumed the effectiveness shown in the simulations could be extended to all incidents; however, of the 511 deaths replicated in the simulations, less than 2 percent (8 deaths) replicated the scenario of the generator operating outdoors the entire time, whereas CPSC's fatality data shows that 6 percent of the deaths were reported to have occurred with the generator operating outdoors (79 out of 1332 deaths, as of May 10, 2022). Thus, the outdoor scenario is underrepresented in the injury estimates. Taking into consideration the diminished CO concentrations around the portable generator when it is operated outside, the Commission believes the effectiveness rate of G300-compliant generators in reducing injuries may be overstated, and the benefits of implementing the emission requirements of UL 2201 are consequently understated. The Commission requests information regarding CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors.

Depending on the emission control strategy that manufacturers use to meet the CO emission rate performance requirement in the proposed rule, it is possible product modifications made to comply with the proposed rule could improve portable generators' fuel-efficiency, as

[45] The shutoff systems required by PGMA G300 and UL 2201 are expected to perform well indoors. When the generator is operated outdoors, however, weather conditions, the direction of the generator exhaust, and other situational factors may lower the level of CO concentration near the generator and not activate the shutoff system. Because G300 does not require a CO emission rate reduction, a G300-compliant portable generator (that is not compliant with UL 2201) running outdoors that does not shut off presents the same risk of CO poisoning as a noncompliant generator.

well as other characteristics such as ease of starting, altitude compensation, fuel adaptability, power output, reliability, and engine life. The Commission did not quantify the secondary benefits associated with these features, but if these incremental benefits were realized, they would improve the overall benefit-cost ratio of the proposed rule.

Regarding costs, an underlying assumption in this assessment is that there would be no behavioral adaptation in response to the reduced rate of CO emissions from portable generators under the proposed rule. However, consumers' perceptions of injury likelihood and health impacts may be affected by the reduced CO emissions and shutoff features under the rule, which may give consumers a greater sense of security from CO hazards. This, in turn, could result in less careful behavior.

In addition, the portable generators within the scope of this proposed rule are commonly used by consumers to provide electrical power during power outages caused by storms, and at other times when power has been shut off to a home. In a small number of instances, CO sensor failures that cause shutoff pursuant to the Commission's rule, that would not have occurred absent the rule, may disrupt these critical uses of portable generators and produce disutility costs that are not reflected in the costs estimated above. We seek comment on this possibility.

D. Evaluation of Voluntary Standards

The Commission finds that while the existing voluntary standards are not adequate to address the CO hazard for portable generators, requirements in the UL 2201 and PGMA G300 voluntary standards are effective when paired with the additional requirements in the proposed rule. In particular, under simulated conditions, the sensor/shutoff and emission requirements in UL 2201 would have averted essentially all of the deaths related to portable generators. Consequently, high levels of compliance with these requirements would greatly reduce deaths

associated with consumers' use of portable generators. However, to achieve the simulated level of efficacy in real-life situations, there are a number of environmental factors and other considerations that must be addressed. These considerations create the need for additional requirements, which in some cases can be found in the PGMA G300 standard. Some of these requirements relate to the shutoff system's construction, ability to self-monitor, and tamper resistance. There are also requirements related to the inclusion of a CO shutoff notification system and labeling (to make the consumer aware of the reason for the shutoff), as well as requirements related to the inclusion of a notification marking the direction of the engine exhaust and instructions to direct the exhaust away from the occupied structures (to ensure safe operation outdoors), among others. Without these additional requirements, the real-world effectiveness of the standard is unlikely to approach the simulated level of efficacy. For these reasons, the proposed rule does not implement UL 2201 as the mandatory standard, but instead takes key requirements from both standards and adds additional requirements needed to reduce the risk of CO poisoning from operation of portable generators by consumers.

Even if UL 2201 included all the requirements discussed in the previous paragraph, the need for a mandatory standard arises also as a result of a low level of manufacturer compliance with either voluntary standard, and the UL standard in particular. Staff reviewed portable generator models available for sale and found that non-compliant generators are prevalent. The large majority of models produced by smaller manufacturers abroad are non-compliant with either standard. Staff also conducted surveys of large U.S. manufacturers and found that compliance with UL 2201 is minimal, with most manufacturers lacking a clear path for implementation or even plans to become compliant with UL 2201. See Tab B of Staff's SNPR Briefing Package.

E. Alternatives to the Proposed Rule

The Commission considered five alternatives to the proposed rule: (1) implement the proposed rule without the emission requirements included in UL 2201 and using the CO concentration limits required for shutoff that are found in PGMA G300-2018; (2) rely on the voluntary standard organizations' adoption of the requirements of the proposed rule into one of the voluntary standards; (3) issue a rule that relies on either UL 2201 2nd Edition or PGMA G300-2018 as they are currently written; (4) continue to conduct education and information campaigns regarding the CO hazard from portable generators, and (5) take no action. Each alternative is discussed below.

1. Implement the Proposed Rule Without the Emission Requirements and CO Concentrations for Shutoff from UL 2201

An alternative to the proposed rule is to require portable generator manufacturers to comply with the PGMA G300-2018 voluntary standard with only the modifications required to ensure durability, reliability, and safe operation of the sensor/shutoff system. The Commission considered this alternative because it provides some reduction of risk of acute CO poisoning from portable generators in enclosed spaces, and also because implementation costs are likely lower, while current compliance with the voluntary sensor/shutoff requirement is higher (compared to compliance with the UL standard's emission requirement). The Commission preliminarily rejects this alternative because it would result in 372 more deaths and 11,135 more injuries over 30 years compared to the proposed rule, and the net benefits of the proposed rule are higher than the benefits of this alternative. Tab B of Staff's SNPR Briefing Package provides a more in-depth analysis of this alternative.

2. Await Possible Adoption of the Proposed Rule Requirements into UL 2201 or PGMA G300

Alternative 2 proposes reliance on voluntary standard stakeholders to adopt all the requirements included in the proposed rule into either the UL 2201 or the PGMA G300 voluntary standard. The Commission is not proposing to adopt this alternative because obtaining consensus on a voluntary standard that has all the requirements of the proposed rule is unlikely, and staff assesses that current compliance with either voluntary standard is low. Therefore, it is reasonable to assume that even if a voluntary standard with all of the proposed rule's requirements were to achieve consensus, it would not be substantially complied with by manufacturers.

3. Issue a Rule that Relies on Either UL 2201 2nd Edition or PGMA G300-2018 as Currently Written

This alternative to the proposed rule would require portable generators to comply with either the UL 2201 (2nd Edition; 2018) or PMGA G300-2018. The Commission is not proposing this alternative because, as explained earlier, neither standard is adequate. The Commission assesses that the shutoff requirements in PGMA G300 would leave 69 of the 511 fatalities in the staff/NIST simulation unaddressed. In addition, other requirements of PGMA G300 are not adequate such as those for tamper resistance, verifying compliance with the shutoff requirements, and notification and labeling requirements.

The Commission assesses that the CO emission rate and shutoff performance requirements from UL 2201 are extremely effective in reducing the risk injury or death associated with CO poisoning from portable generators. This standard, however, lacks the

requirements necessary to ensure the durability, reliability, and functionality of the CO shutoff system and notification and labeling requirements.

4. Not Issue a Rule and Continue to Conduct Information and Education Campaigns

The Commission considered the merits of continuing to conduct education and information campaigns without a rule, as an alternative to the proposed rule. Existing CPSC education and information campaigns on the hazards associated with CO, and continued CPSC advocacy on smoke and CO alarm adoption, could potentially avoid some deaths associated with portable generators. The Commission supports and acknowledges the importance of such efforts; however, these efforts have not resulted in a decrease in the number of annual generator-related CO deaths, and in fact, deaths have increased in recent years.

5. Take No Action

Finally, the Commission considered the merits of taking no action. An assessment of the trends in deaths and injuries and the low adoption of the voluntary standards, indicate this problem will not correct itself. Over the next 30 years at current levels of compliance with the voluntary standards, deaths are expected to exceed 2,600 with roughly 154,000 injuries, and a total societal cost in excess of $27 billion (discounted at 3 percent). See Tab B of Staff's SNPR Briefing Package. For these reasons, the Commission is not adopting this alternative.

VIII. Initial Regulatory Flexibility Analysis

Whenever an agency publishes an NPR, Section 603 of the Regulatory Flexibility Act (RFA), 5 U.S.C. 601–612, requires agencies to prepare an initial regulatory flexibility analysis (IRFA), unless the head of the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. The IRFA, or a summary of it, must be

published in the *Federal Register* with the proposed rule. Under Section 603(b) of the RFA, each IRFA must include:

(1) a description of why action by the agency is being considered;

(2) a succinct statement of the objectives of, and legal basis for, the proposed rule;

(3) a description and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

(4) a description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

(5) an identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the proposed rule.

The IRFA must also describe any significant alternatives to the proposed rule that would accomplish the stated objectives and that minimize any significant economic impact on small entities. Staff's initial regulatory flexibility analysis is provided in Tab C of Staff's SNPR Briefing Package.

A. Reason for Agency Action

The purpose of this rulemaking is to reduce the risk of death or injury from acute CO poisoning resulting from consumer use of portable generators. There were at least 1,332 deaths involving portable generators from 2004 through 2021 as of May 10, 2022 (see Section IV. of this preamble), or an average of about 74 annually. From 2004 through 2021, there were a total of 17,569 nonfatal CO poisonings involving portable generators that were treated in hospital emergency departments (about 976 annually); 7,308 hospital admissions (an average of 406 per

year); and 52,782 medically attended injuries treated in other settings (an estimated 2,932 per year). The Commission is promulgating the proposed rule to reduce these generator-related CO injuries and deaths and the associated societal costs. Although there are two voluntary standards that address CO poisoning from portable generators, the Commission assesses that there is not substantial compliance with these voluntary standards throughout the industry, nor would adoption of either of these standards reduce the hazard risk as effectively as the proposed rule.

B. Objectives and Legal Basis for the Rule

The Commission proposes this rule to reduce deaths and injuries resulting from acute exposure to CO associated with portable electric generators. The Commission published an advance notice of proposed rulemaking in December 2006, which initiated this proceeding to evaluate regulatory options and potentially develop a mandatory standard to address the risks of acute CO poisoning associated with the use of portable generators. In 2016, the Commission published a notice of proposed rulemaking (NPR) that proposed CO emission rate requirements for portable generators based on four different categories of engine sizes. PGMA and UL published revisions to their voluntary standards in 2018. The Commission has assessed the effectiveness of the CO-mitigation provisions in the voluntary standards and preliminarily concludes that neither standard is adequate to address the unreasonable risk of injury associated with portable generators. Additionally, Commission data indicate that compliance with PGMA G300 and UL 2201 has not increased substantially since the publication of their 2018 revisions while the number of deaths and injuries has continued to increase. See Tab B of Staff's SNPR Briefing Package. The Commission concludes a mandatory standard is required to reduce the significant hazards associated with this consumer product. The proposed rule is being issued under the authority of sections 7 and 9 of the CPSA.

C. Small Entities to Which the Rule Will Apply

The proposed rule would apply to all entities that manufacture or import portable generators that are powered by spark-ignited engines. Based on data collected by Power Systems Research, along with other market research, staff identified 110 manufacturers of generators that have at some time supplied portable generators to the U.S. market. Most of these manufacturers were based in other countries. Staff identified 13 domestic manufacturers of gasoline, natural gas, and LPG-powered portable generators, four of which would be considered small based on the Small Business Administration size guidelines. Three of the four small manufacturers are primarily engaged in the manufacture or supply of larger, commercial, industrial, or backup generators, or other products, such as electric motors, that are not subject to the proposed rule. For the one remaining small manufacturer, portable generators likely account for a significant portion of that firm's total sales.

Using the same sources of data described above, staff identified more than 90 firms that have produced or imported gasoline and LPG-powered portable generators. However, in most cases, these firms have not imported portable generators regularly, or portable generators account for an insignificant portion of their sales. Of these 90 firms, staff assessed that 20 may be small importers of gasoline and propane-powered portable generators that could be affected by the proposed rule.

D. Compliance, Reporting, and Record-Keeping Requirements of Proposed Rule

The CPSA requires manufacturers (the term includes importers) to certify that their products comply with applicable CPSC standards and regulations. 15 U.S.C. 2063(a)(1). If the Commission should finalize a portable generator rule, manufacturers, including importers, would need to certify that the product conforms to the standard. For products that manufacturers

certify, manufacturers would issue a general certificate of conformity (GCC). The requirements for the GCC are stated in Section 14 of the CPSA and discussed in Tab C of Staff's SNPR Briefing Package.

E. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rule

CPSC has not identified any other Federal rules involving the risk of acute CO poisoning from portable generators that duplicate, overlap, or conflict with the proposed rule.

F. Potential Impact on Small Entities

1. Impact on Small Manufacturers

To comply with the proposed rule, small manufacturers would incur the costs to redesign, test, and manufacture compliant generators. As discussed in the preliminary regulatory analysis (Section VII of this preamble), the undiscounted cost of redesigning, testing, and manufacturing associated with the proposed rule is expected to be, on average, about $53.38 per portable generator upgraded because of the proposed rule, or $34.22 discounted at 3 percent. The retail prices staff observed for portable generators from manufacturers and importers of all sizes ranged from a low of $149 to $6,649, depending upon the characteristics of the generator. The estimated average increase of $34.22 in discounted costs represents roughly 3 percent of the average retail price of a portable generator.

Generally, impacts that exceed one percent of a firm's revenue are considered to be potentially significant. Depending on the size of the generator, the average discounted cost of the upgrade would be between 0.5 percent and 23 percent of the retail prices (or average revenue) of generators; therefore, the proposed rule could have a significant impact on manufacturers and importers that receive a significant portion of their revenue from the sale of the lowest priced portable generators.

2. Impact on Small Importers

For small importers, the impact of the proposed rule would be similar to small manufacturers. In some cases, the foreign suppliers could opt to withdraw from the U.S. market rather than incur the costs of redesigning their generators to comply with the proposed rule. If this occurs, the domestic importers will have to find other suppliers of portable generators or exit the portable generator market. Exiting the portable generator market could be considered a significant impact if portable generators accounted for a significant percentage of the firm's revenue. However, at least three of these firms focus on mobile generators, which are not the same as portable and are generally larger products that are trucked to a site in need of electricity for industrial or business requirements.

Small importers will be responsible for issuing a GCC certifying that their portable generators comply with the proposed rule should it becomes final. However, importers may rely upon testing performed and GCCs issued by their suppliers in complying with this requirement.

3. Alternatives Considered to Reduce the Burden on Small Entities

Under section 603(c) of the Regulatory Flexibility Act, 5 U.S.C. 603(c), an initial regulatory flexibility analysis should "contain a description of any significant alternatives to the proposed rule which accomplish the stated objectives of the applicable statutes and which minimize any significant impact of the proposed rule on small entities." The Commission examined several alternatives to the proposed rule which could reduce the impact on small entities. These alternatives, along with the reasons the Commission is not adopting them, are discussed in section VII.G of this preamble.

IX. Response to Comments

Based on changes to the proposed requirements in the SNPR compared to those initially proposed in the NPR, many of the comments to the 2016 NPR are no longer pertinent. Many other comments have been addressed since the NPR through staff's simulation plan and effectiveness analysis of the CO mitigation requirements in the voluntary standards. Following is a summary of and response to significant comments received following publication of the 2016 NPR.

Different emission rates based on engine size.

(Comment 1) Four commenters (PGMA, Briggs & Stratton, Champion Power Equipment, and Generac) objected to the 2016 NPR's proposal of four different levels of maximum CO emissions, depending on the size of engine. Commenters claimed that the tiered emission levels were based on achievable rates using best available technology rather than evidence regarding the safety of the levels. These commenters claimed that the impact on consumer safety or the reduction of CO injuries was not clearly presented for each of these tiered levels.

(Response 1) The proposed requirements detailed in this SNPR do not require different rates for different engine sizes. The requirements of the current proposed rule, which are applicable to generators of all engine sizes, are expected to eliminate nearly all deaths and most injuries.

Mandatory label for portable generators has accomplished what is necessary.

(Comment 2) PGMA and Briggs & Stratton claimed that, since the introduction of CPSC's 2007 mandatory portable generator safety label, 16 CFR part 1407, the rate of unintentional CO fatalities associated with portable generators had decreased.

(Response 2) Staff disagrees. The effective date of CPSC's mandatory label was February 2007, which was more than 15 years ago. As the data in Figure 1 of this preamble show, there has

been no obvious and consistent reduction in CO fatalities since that time, and CO fatalities associated with portable generators have been increasing in recent years. While data collection for 2020 is ongoing, the number of CO deaths caused by portable generators in 2020 is likely to exceed the highest number of annual deaths over the reporting period of 2004 to 2021, which occurred in 2005 (103 deaths), prior to the mandatory label.

Authority to regulate.

(Comment 3) Four commenters (PGMA, Briggs & Stratton, Generac, and the Truck and Engine Manufacturers Association) stated that pursuant to section 31 of the CPSA, the CPSC lacks the authority to regulate the risk of injury associated with CO emissions from portable generators because that risk could be addressed by EPA under the Clean Air Act (CAA), 42 U.S.C. 7401 *et seq*.

(Response 3) Section 31 provides that the CPSC lacks authority to regulate a consumer product if that risk "could be eliminated or reduced to a sufficient extent through actions" taken under the CAA or other listed statutes. 15 U.S.C. 2080(a). The legislative history reveals that Congress contemplated a stricter ban on CPSC's jurisdiction but rejected it. The Senate version of the language that became section 31 would have precluded CPSC's jurisdiction if the product was "subject to safety regulation," defined as "authorized to be regulated for the purpose of eliminating any unreasonable risk of injury or death," under any of the statutes listed.[49] The House version of the bill, which was eventually enacted, instead gave the Commission the authority to regulate if the risk of injury cannot be reduced to a sufficient extent under one of the enumerated Acts.[50] The Conference Report explains:

[49] S. Rep. No. 92-749, 92d Cong., 2d Sess. 12-13 (1972).
[50] H.R. Rep. No. 92-1593, 92d Cong., 2d Sess. 38 (1972).

> In determining whether a risk of injury can be reduced to a sufficient extent under one of the Acts referred to in this section, it is anticipated that the Commission will consider all aspects of the risk, together with the remedial powers available, to it under both the bill and the remedial powers under the other law available to the agency administering the law.

Id.

Case law confirms that section 31 does not restrict CPSC from regulating simply because another agency has acted or could act in the same area. In *ASG Industries, Inc. v. CPSC,* 593 F.2d 1323 (D.C. Cir. 1979), the D.C. Circuit rejected the argument that the Commission lacked authority to regulate architectural glazing materials used in most non-residential buildings because it could be regulated under the Occupational Safety and Health Act (OSHA), which is a statute listed in section 31. The court concluded "that CPSA § 31 was not intended to preclude the exercise of jurisdiction by CPSC whenever a product-hazard either potentially could be or was in part being regulated under OSHA. Congress required CPSC to make a judgement." 593 F.2d at 1328-29.

Section 213(a)(1) of the CAA directs the EPA to conduct a study of emissions from nonroad engines to determine if they cause or contribute to air pollution, "which may reasonably be anticipated to endanger public health or welfare." Within 12 months of completion of the study, section 213 directs the EPA to make a determination on whether CO emissions from nonroad engines are "significant contributors to ozone or carbon monoxide concentrations in more than 1 area which has failed to attain the national ambient air quality standards for ozone or carbon monoxide." 42 U.S.C. 7547(a)(2).

The statutory authority for EPA to address CO emissions thus is tied to a determination that the emissions are contributing to air pollution. The CPSC does not seek to address the effects of CO emission on ambient air pollution, but instead, the acute CO poisoning hazard to consumers associated with use of portable generators in which nonroad spark engines are installed.

EPA's large-scale focus on carbon monoxide emissions is not directed to the protection of individual consumers from carbon monoxide poisoning. The risk of CO poisoning from portable generators has persisted, and deaths and injuries associated with CO emissions from portable generators have increased, even with EPA's adoption of regulations to limit CO emissions from nonroad spark engines to address air pollution and ambient air quality. This rulemaking is intended to address this acute risk to consumers of CO poisoning from portable generators and is within CPSC's regulatory authority.

Include compression units within the scope of the rule.

(Comment 4) PGMA stated that any proposed requirement should be applicable to all portable generators, not just spark-ignited units. PGMA pointed out that compression units, as well are within the scope of the PGMA G300 voluntary standard.

(Response 4) The Commission disagrees. Compression ignition engines[51] (*i.e.*, diesel engines) emit significantly less CO compared to spark ignited engines. CPSC staff has not identified any fatality as involving emissions from a diesel generator. Furthermore, diesel generators are primarily used by individuals in a work-related setting or environment, and typically are not

[51] Compression ignition engines use a higher compression ratio than a spark to heat air in the engine cylinder, and thus do not use a spark plug to ignite the air-fuel mixture.

consumer products. Thus, the Commission is not including diesel generators in the scope of the proposed rule.

CO shutoff system.

(Comment 5) Four commenters (PGMA, Briggs & Stratton, Generac, and Champion) stated that the 2016 NPR did not adequately consider the potential for using generator shutoff concepts. The commenters asserted that the CO shutoff solution was a more feasible and reliable solution to that proposed in the 2016 NPR.

(Response 5) The revised proposed rule includes requirements for a CO shutoff system.

Modeling of generators running outdoors.

(Comment 6) PGMA and Briggs & Stratton stated that CPSC needs to conduct modeling of generators running outdoors.

(Response 6) The analyses of the PGMA G300 and UL 2201 voluntary standards that support this SNPR include results from testing and modeling of generators running outdoors.

Closed loop electronic fuel injection system (EFI) and catalyst.

(Comment 7) Four commenters (PGMA, Generac, Briggs & Stratton, and the Truck and Engine Manufacturers Association) stated that the NPR proposed to reduce CO emission rates using closed loop electronic fuel ignition (EFI) and 3-way catalysts, and that these technologies can be detrimental to a catalyst-equipped air-cooled engine's durability, performance, and emissions maintenance. PGMA has also alleged that the elevated exhaust temperatures from these technologies could lead to burn and fire hazards.

(Response 7) The 2016 NPR did not prescribe emissions control technologies. As discussed in more detail in Staff's SNPR Briefing Package, staff has observed portable generator models currently in the marketplace that are certified to UL 2201 and/or appear to meet the CO emission

rate of the proposed rule, using various technologies as well as techniques to address additional heat.

Elimination of LPG and dual fuel generators from the market.

(Comment 8) In response to the requirements in the 2016 NPR, Champion and Generac stated that if EFI is the primary technical solution adopted to achieve compliance, then the standard would eliminate conventional and dual fuel generators from the market. The commenters stated that LPG and dual fuel generators represent a significant portion of portable generator sales.

(Response 8) The proposed rule does not prescribe how manufacturers must meet the CO emission rate requirement. Manufacturers are using different emission control strategies to lower the CO emission rate to levels the Commission expects will meet the CO emission rate requirement in the proposed rule. Furthermore, due to propane's chemical composition, it produces less CO compared to gasoline, thereby making it less challenging for an LPG generator to meet the proposed rule than a gasoline generator of equivalent rated wattage.

False sense of security.

(Comment 9) Four commenters (PGMA, Briggs & Stratton, Champion, and Generac) claimed that consumers may mistakenly believe that reduced CO emissions means it is safe to operate a portable generator indoors.

(Response 9) The revised proposed rule does not rely on reduced emissions alone. The proposed rule's addition of a shutoff requirement, similar to that supported by PGMA in response to the 2016 NPR, further reduces the risk of death and injury from these products.

PGMA G300

(Comment 10) Three commenters (PGMA, Generac, Briggs & Stratton) asserted that the then-proposed revisions to PGMA G300 (now part of PGMA G300-2018), would address nearly all fatalities resulting from misuse of portable generators in enclosed spaces.

(Response 10) The Commission disagrees. The effectiveness analysis that replicated 511 generator-related CO deaths in CPSC's databases found that if the generators complied with PGMA G300, there still would have been 69 deaths. Moreover, of the 442 survivors from the 511 simulations assuming G300 compliance, 142 would have been injured such that 54 would have been hospitalized and 88 would have been treated and released.

Additionally, staff's testing of commercially available generators compliant with PGMA G300 and UL 2201, documented in NIST Technical Note 2200,[52] show that two generators that were PGMA G300-compliant, when run in an attached garage with the bay door fully open, did not result in localized CO levels sufficient to activate the CO shutoff system, yet resulted in CO concentrations in the living space of the house that would have caused injuries to the home's occupants. In one test, the generator ran out of fuel after 329 minutes, resulting in COHb values for theoretical occupants in the house that peaked in the range of 27 percent to 37 percent. This is in the range of where symptoms such as severe headache, nausea, vomiting, and cognitive impairment are expected to occur. In the other test, the generator ran for 468 minutes before the test operator manually shut the generator off because of time constraints and stopped data collection. The COHb values for theoretical occupants at the time the generator was stopped ranged from 20 percent to 26 percent, which is in the range of where symptoms such as

[52] NIST TN 2200 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Commercially Available Portable Generators Equipped with a CO Hazard Mitigation System*, available online https://doi.org/10.6028/NIST.TN.2200

throbbing headache and mild nausea are expected to occur. Furthermore, PGMA G300 does not address deaths and injuries from generators used outdoors, where local CO concentrations are less likely to build to a sufficient level to activate the CO shutoff system, as evidenced by a 3-fatality incident involving a PGMA G300 generator used outside and near a home. See Tab G of Staff's SNPR Briefing Package.

X. Incorporation by Reference

The Commission proposes to incorporate by reference UL 2201, *Standard for Safety, Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition,* and ANSI/PGMA G300-2018 (Errata Update), *Safety and Performance of Portable Generators.* The Office of the Federal Register (OFR) has regulations regarding incorporation by reference. 1 CFR part 51. Under these regulations, agencies must discuss, in the preamble, ways in which the material the agency incorporates by reference is reasonably available to interested parties, and how interested parties can obtain the material. In addition, the preamble must summarize the material. 1 CFR 51.5(b).

In accordance with the OFR regulations, section V of this preamble summarizes the major provisions of UL 2201 and PGMA G300 that the Commission proposes to incorporate by reference into 16 CFR part 1241. The standards are reasonably available to interested parties. Interested parties can schedule an appointment to inspect a copy of the standard at CPSC's Office of the Secretary, U.S. Consumer Product Safety Commission, 4330 East West Highway, Bethesda, MD 20814, telephone: (301) 504-7479; e-mail: cpsc-os@cpsc.gov. In addition, UL 2201 is available for free digital view at www.shopulstandards.com/ProductDetail.aspx?productId=UL2201_2_S_20180109. Interested

parties can purchase a copy of UL 2201 from www.shopulstandards.com. PGMA G300 is available for free download at www.pgmaonline.com/publications.asp.

XI. Environmental Considerations

Generally, the Commission's regulations are considered to have little or no potential for affecting the human environment, and environmental assessments and impact statements are not usually required. See 16 CFR § 1021.5(a). The proposed rule is not expected to have an adverse impact on the environment and is considered to fall within the "categorical exclusion" for the purposes of the National Environmental Policy Act. 16 CFR § 1021.5(c).

XII. Preemption

Executive Order (EO) 12988, Civil Justice Reform (Feb. 5, 1996), directs agencies to specify the preemptive effect of a rule in the regulation. 61 FR 4729 (Feb. 7, 1996). The proposed regulation for portable generators is issued under authority of the CPSA. 15 U.S.C. 2051-2089. Section 26 of the CPSA provides that "whenever a consumer product safety standard under this Act is in effect and applies to a risk of injury associated with a consumer product, no State or political subdivision of a State shall have any authority either to establish or to continue in effect any provision of a safety standard or regulation which prescribes any requirements as to the performance, composition, contents, design, finish, construction, packaging or labeling of such product which are designed to deal with the same risk of injury associated with such consumer product, unless such requirements are identical to the requirements of the Federal Standard." *Id.* 2075(a). Thus, the proposed rule for portable generators, if finalized, would preempt non-identical state or local requirements for portable generators designed to protect against the same risk of injury.

States or political subdivisions of a state may apply for an exemption from preemption regarding a consumer product safety standard, and the Commission may issue a rule granting the exemption if it finds that the state or local standard: (1) provides a significantly higher degree of protection from the risk of injury or illness than the CPSA standard, and (2) does not unduly burden interstate commerce. *Id.* 2075(c).

XIII. Paperwork Reduction Act

This proposed rule contains information collection requirements that are subject to public comment and review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1995 (PRA). 44 U.S.C. 3501–3520. We describe the provisions in this section of the document with an estimate of the annual reporting burden. Our estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing each collection of information.

CPSC particularly invites comments on: (1) whether the collection of information is necessary for the proper performance of the CPSC's functions, including whether the information will have practical utility; (2) the accuracy of the CPSC's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used; (3) ways to enhance the quality, utility, and clarity of the information to be collected; (4) ways to reduce the burden of the collection of information on respondents, including the use of automated collection techniques, when appropriate, and other forms of information technology; and (5) estimated burden hours associated with label modification, including any alternative estimates.

Title: *Safety Standard for Portable Generators*

Description: The proposed rule would require each portable generator to comply with the labeling requirements in PGMA G300, *Safety and Performance of Portable Generators,* with modifications. Sections 7.2 of PGMA G300 contains requirements for labels, warnings and instructional literature.

Description of Respondents: Persons who manufacture or import portable generators.

Staff estimates the burden of this collection of information as follows in Table 14:

Table 14. Estimated Annual Reporting Burden

Burden Type	Number of Respondents	Frequency of Responses	Total Annual Responses	Hours per Response	Total Burden Hours	Annual Cost
Labeling	110	12		1	1,320	$39,930.00
Testing	110	12		4	5,280	$384,964.80
Total Burden					6,600	$424,894.80

Our estimate is based on the following. There are 110 known entities supplying portable generators to the U.S. market. On average, each entity supplies 12 portable generator models to the market. All 110 entities are assumed to already use labels on both their products and packaging. However, all of the entities will need to make modifications to their existing labels to comply with the proposed rule. The estimated time required to make these modifications to the labeling is about 1 hour per model. Each entity supplies an average of 12 different portable generator models. Therefore, the estimated burden associated with labels is 1,320 hours (110 entities × 12 models per entity x 1 hour per model = 1,320 hours). We estimate the hourly compensation for the time required to create and update labels is $30.25 (U.S. Bureau of Labor Statistics, "Employer Costs for Employee Compensation," March 2022, total compensation for

all sales and office workers in goods-producing private industries: www.bls.gov/ncs/.) Therefore, the estimated annual cost to industry associated with the labeling requirements is $39,930 ($30.25 per hour × 1,320 hours). There are no operating, maintenance, or capital costs associated with the collection.

The proposed rule would also require that manufacturers certify that their products conform to the rule and issue a GCC. There are 110 known entities supplying portable generators to the U.S. market. On average, each entity supplies 12 portable generators to the market. Issuing a GCC would be new for all 110 manufacturers. The estimated time required to test the product and issue a GCC is about 4 hours per model. Each entity supplies an average of 12 different portable generator models. Therefore, the estimated burden associated with testing and issuance of a GCC is 5,280 hours (110 entities × 12 models per entity × 4 hours per model = 5,280 hours). We estimate the hourly compensation for the time required to test and issue GCCs is $72.91 (U.S. Bureau of Labor Statistics, "Employer Costs for Employee Compensation," March 2022, total compensation for all sales and office workers in goods-producing private industries: www.bls.gov/ncs/.) Therefore, the estimated annual cost to industry associated with testing and issuance of a GCC is $384,964.80 ($72.91 per hour × 5,280 hours). There are no operating, maintenance, or capital costs associated with the collection.

Based on this analysis, the proposed standard for portable generators would impose a burden to industry of 6,600 hours, at an estimated cost of $424,894.80 annually ($39,930.00 + $384,964.80). Existing portable generator entities would incur these costs in the first year following the proposed rule's effective date. In subsequent years, costs could be less, depending on the number of new portable generator models introduced by existing entities and/or by entities entering the portable generator market. As required under the PRA (44 U.S.C. 3507(d)), CPSC

has submitted the information collection requirements of this proposed rule to the OMB for review. Interested persons are requested to submit comments regarding information collection by [**insert date 30 days after date of publication in the FEDERAL REGISTER**], to the Office of Information and Regulatory Affairs, OMB as described under the **ADDRESSES** section of this notice.

XIV. Certification

Section 14(a) of the CPSA requires that products subject to a consumer product safety rule under the CPSA, or to a similar rule, ban, standard or regulation under any other act enforced by the Commission, must be certified as complying with all applicable CPSC-enforced requirements. 15 U.S.C. 2063(a). A final rule would subject portable generators to this requirement.

XV. Effective Date

The Administrative Procedure Act (APA) generally requires that the effective date of a rule be at least 30 days after publication of a final rule. 5 U.S.C. 553(d). Section 9(g)(1) of the CPSA states that a consumer product safety rule shall specify the date such rule is to take effect, and that the effective date must be at least 30 days after promulgation but cannot exceed 180 days from the date a rule is promulgated, unless the Commission finds, for good cause shown, that a later effective date is in the public interest and publishes its reasons for such finding.

For this proposed rule, the Commission is proposing an effective date of 180 days after publication of the final rule in the *Federal Register*, and the rule would apply to portable generators manufactured after the effective date. The 2016 NPR proposed an effective date 1 year after publication of the final rule for larger generators and 3 years for smaller generators, to allow enough time to comply. However, significant changes have occurred since the NPR. The

Commission assesses that a 1-year effective date for larger generators, and 3-year effective date for smaller generators, is no longer necessary.

Since the NPR, industry has published voluntary standards and some manufacturers have adopted them, which demonstrate their feasibility. In 2018, UL published UL 2201, which has a requirement of a maximum weighted CO emission rate of 150 g/h for all portable generators.[53] At least one portable generator manufacturer currently certifies products to both UL 2201 and PGMA G300. Two other manufacturers each have one model in the marketplace that are certified to PGMA G300; and although not certified to UL 2201, CPSC staff expects these models would meet the proposed rule's CO emission rate requirement. One is a popular model of a brand-name gasoline generator that has been converted to run on propane, and the other is a recently introduced gasoline generator.

Notwithstanding these models currently on the market, the Commission assesses that most manufacturers will likely need time to develop, test, and plan for production of portable generators that would meet the proposed requirements, particularly the CO emission rate requirement. While the technology that the proposed rule would require is based on existing technology and the requirements are based on those in the existing voluntary standards, portable generators will need to be altered to be compliant. Therefore, the Commission is proposing 180 days, the maximum time allowed under CPSA section 9 absent a special showing of good cause, and seeks public comment on this time frame.

[53] *UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition,* Dated January 9, 2018.

XVI. Request for Comments

We invite all interested persons to submit comments on any aspect of the proposed rule. Specifically, the Commission seeks comments on the following:

- Information regarding CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors;

- Information regarding any potential costs or benefits of the proposed rule that were not included in the foregoing preliminary regulatory analysis;
- Information regarding the number of small businesses impacted by the proposed rule and the magnitude of the impacts of the proposed rule;
- Information regarding potential differential impacts of the proposed rule on small manufacturers or suppliers that compete in different segments of the portable generator market;
- Whether any manufacturing costs that might disproportionately impact small businesses were not considered in this analysis;
- Whether the potential for CO sensor failures during usage in emergency situations that cause shutoff, that would not have occurred absent the rule, should be considered as a reduction in consumer welfare;
- Information regarding the necessity of a minimum luminance requirement for the indication associated with the notification for the portable generator system for controlling CO exposure, and what an appropriate luminance requirement might be;
- Information regarding CPSC's jurisdiction to regulate the acute CO poisoning hazard from portable generators, including information from interested agencies;
- Information regarding whether PGMA G300's minimum notification indication duration of 5 minutes after shutoff occurs, unless the generator is restarted, is sufficient;
- Information regarding the costs of the testing and certification requirements of the proposed rule; and

- The appropriateness of the 180-day effective date. Comments recommending a longer effective date should describe the problems associated with meeting the proposed effective date and the justification for a longer one.

XVII. Notice of Opportunity for Oral Presentation

Section 9 of the CPSA requires the Commission to provide interested parties "an opportunity for oral presentation of data, views, or arguments." 15 U.S.C. 2058(d)(2). The Commission must keep a transcript of such oral presentations. *Id.* Any person interested in making an oral presentation must contact the Commission, as described under the **DATES** and **ADDRESSES** section of this notice.

XVIII. Promulgation of a Final Rule

Section 9(d)(1) of the CPSA requires the Commission to promulgate a final consumer product safety rule within 60 days of publishing a proposed rule. 15 U.S.C. 2058(d)(1). Otherwise, the Commission must withdraw the proposed rule if it determines that the rule is not reasonably necessary to eliminate or reduce an unreasonable risk of injury associated with the product or is not in the public interest. *Id*. However, the Commission can extend the 60-day period, for good cause shown, if it publishes the reasons for doing so in the *Federal Register*. *Id*.

The Commission finds that there is good cause to extend the 60-day period for this rulemaking. There have been substantial changes to the relevant voluntary standards, as well as extensive technical investigation requiring substantial time, since publication of the NPR in 2016. Regarding this SNPR and a final rule, under both the APA and the CPSA, the Commission must provide an opportunity for interested parties to submit written comments on a proposed rule. 5 U.S.C. 553; 15 U.S.C. 2058(d)(2). The Commission is providing 60 days for interested parties to submit written comments. Additionally, the CPSA requires the Commission

to provide interested parties with an opportunity to make oral presentations of data, views, or arguments. 15 U.S.C. 2058. This requires time for the Commission to arrange a public meeting for this purpose and provide notice to interested parties in advance of that meeting, if any interested party requests the opportunity to present such comments. After receiving written and oral comments, CPSC staff must have time to review and evaluate those comments.

These factors make it impractical for the Commission to issue a final rule within 60 days of this proposed rule. Issuing a final rule within 60 days of this SNPR may limit commenters' ability to provide useful input on the rule, and CPSC's ability to evaluate and take that information into consideration in developing a final rule. Accordingly, the Commission finds that there is good cause to extend the 60-day period for promulgating the final rule.

List of Subjects

16 CFR Part 1241

Administrative practice and procedure, Consumer protection, Incorporation by reference, Portable Generators.

For the reasons discussed in this preamble, the Commission proposes to amend Title 16 of the Code of Federal Regulations by adding a new part to read as follows:

PART 1241—SAFETY STANDARD FOR PORTABLE GENERATORS

Sec.

Authority: 15 U.S.C. 2056, 2058.

§ 1241.1 Scope, purpose, and effective date.

(a) This part 1241 establishes a consumer product safety standard for portable generators, as defined in § 1241.1(b), to address the acute carbon monoxide (CO) poisoning hazard associated with portable generators.

(b) For purposes of this rule, portable generators include single-phase, 300 V or lower, 60-hertz generators that are provided with receptacle outlets for alternating current (AC) output circuits and intended to be moved by the consumer, although not necessarily with wheels. The engines in these portable generators are small, nonroad spark-ignition engines, based on the EPA's engine classifications per 40 CFR 1054.801, and are fueled by gasoline, liquified propane gas, or natural gas. For purposes of this rule, portable generators do not include:

(1) Permanent stationary generators;

(2) 50-hertz generators;

(3) Marine generators;

(4) Generators solely intended to be pulled by, or mounted on vehicles;

(5) Generators permanently mounted in recreational vehicles or motor homes;

(6) Generators powered by compression-ignition engines fueled by diesel;

(7) Industrial-type generators intended solely for connection to a temporary circuit breaker panel at a jobsite, and not for consumer use.

(c) Any portable generator manufactured after [**insert date 180 days after date of publication of the final rule in the FEDERAL REGISTER**] shall comply with the requirements stated in §1241.3.

§ 1241.2 Definitions.

In addition to the definitions in section 3 of the Consumer Product Safety Act (15 U.S.C. 2051), the following definitions apply for purposes of this part 1241.

Air change rate, as defined in section 2 of PGMA G300-2018.

CO analyzer, as defined in section 2 of PGMA G300-2018.

CO shutoff system. Same as "portable generator system for controlling CO exposure."

Engine, as defined in section 2 of PGMA G300-2018.

Maximum available observed wattage. Same as rated wattage.

Ordinary tools, as defined in section 2 of PGMA G300-2018.

Portable generator system for controlling CO exposure, as defined in section 2 of PGMA G300-2018.

Rated wattage. The output power rating of a portable generator as determined under section 6.3.2 of PGMA G300-2018.

Test room. A fully enclosed space with a volume of 895 - 2100 ft^3 (25.34 – 59.47 m^3) and a ceiling height of 8 - 12 ft (2.44 – 3.66m). The room dimensions shall allow for the requirements of the generator position to be met. The generator shall be positioned such that the exhaust jet centerline is along one of the room centerlines; the exhaust outlet on the generator is at least 6 ft (1.83m) from the opposite wall; the outer surfaces of the generator housing or frame is at least 3 ft (0.91m) from the walls to other sides; and the onboard CO sensor used for the CO safety shutoff system be at least 1 ft (0.30m) away from any obstruction. The room shall be constructed to control ventilation within a range of 0.1 – 1.0 air changes per hour (ACH). Ventilation shall be induced by a fan on the air outlet. The configuration of the air inlet and outlet for ventilation shall be designed such that neither port creates a flow directly onto or near

the CO analyzer sample port above the generator or the CO sensor onboard the generator that is used as part of the CO safety shutoff system. The CO sample port connected to the CO analyzer for determining the concentration of CO within the test room shall be placed 1 ft (0.30m) above the center point of the portable generator's top surface.

Units of measurement, as defined in section 2.1 of UL 2201.

§ 1241.3 Requirements.

(a) CO Emission Rate Requirements. The calculated weighted CO emission rate of the generator shall not exceed 150 g/h using one of two test methods, either the Portable Generator Assembly CO Emissions Method, as described in section 5.2 of UL 2201, or the Portable Generator Engine-Only CO Emissions Method, as described in section 5.3 of UL 2201.

(b) CO shutoff construction requirements. Comply with section 3.9.1 of PGMA G300, except replace all instances of "810 - 850 ppm*"* with "410 – 450 ppm"; "800 ppm" with "400 ppm"; "810 – 850 ppm" with "410 – 450 ppm"; "410 – 430 ppm" with "160 – 180 ppm"; and "400 ppm" with "150 ppm". Replace each instance of "before" with "at or before".

(c) CO shutoff levels. Comply with section 6.2.11.1 of PGMA G300, except replace 800 ppm with 400 ppm and 400 ppm with 150 ppm.

(d) CO shutoff test method. Comply with section 6.2.11.2 of PGMA G300. The definition of "test room" in § 1241.2 shall apply for purposes of the CO shutoff test method.

(e) Self-monitoring system. Comply with section 3.9.1.1 of PGMA G300-2018.

(f) Tamper resistance.

(1) A portable generator system for controlling CO exposure shall be tamper resistant. The system is considered tamper resistant when any part that is shorted, disconnected, or removed to disable the operation of the system prevents the engine from running. In addition, all

parts, including wiring, which affect proper operation of the portable generator system for controlling CO exposure, must be (a) permanently sealed or (b) not normally accessible by hand or with ordinary tools. It is permissible for different parts of the portable generator system for controlling CO exposure to meet either option (a) or (b), provided all of the different parts meet at least one of these two options.

(2) Comply with section 3.9.1.2.2 – 3.9.1.2.4 of PGMA G300-2018.

(g) Notification.

(1) Comply with 3.9.1.3 of PGMA G300-2018.

(2) The portable generator system for controlling CO exposure shall include a prominent and conspicuous notification of shutoff event or system fault event in a readily visible location to a consumer who is positioned in front of the start-up controls.

(3) CO Shutoff Event Notification. The portable generator system for controlling CO exposure shall provide a notification after a CO shutoff event. The notification shall be a red indication. The red indication shall be at least 0.4 inches (10mm) in diameter, illuminated and, if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark duration. The notification shall remain for a minimum of 5 minutes after a shutoff occurs unless the portable generator engine is restarted. If the portable generator engine is restarted, the notification shall not be present.

(4) System Fault Event Notification. Comply with 3.9.1.3.2 of PGMA G300-2018.

(h) Carbon Monoxide Sensor. Comply with section 3.9.1.4 of PGMA G300-2018.

(i) Shut-Down Safety. Comply with section 4.1.1.1.3 of PGMA G300-2018.

(j) Marketing, labeling and instructional requirements.

(1) Comply with section 7.2.1, 7.2.2.1, 7.2.2.2, 7.2.2.3, and 7.2.2.5 of PGMA G300-2018.

(2) Comply with section 7.2.2. 4 of PGMA G300-2018, with the following changes:

(i) When referring to the placement of the label shown in Figure 5 of PGMA G300-2018, replace "shall be in close proximity to" the notification with "shall be no more than 0.25 inches (6.35 mm) from" the notification.

(ii) Revise the label shown in Figure 5 of PGMA G300-2018 as follows: replace the phrase, "YOU MUST:" with "HIGH LEVELS OF CARBON MONOXIDE."; replace the language in the second panel with the following: "BEFORE RESTARTING, move generator to a more open, outdoor area. Point exhaust away. See DANGER label and product manual for more information."; in the bottom panel, change replace the phrase "IF SICK" with "if you feel sick."; specify that the text in all but the top panel must be formatted using sentence capitalization, except for the following words and phrases: "BEFORE RESTARTING," "DANGER," and "MOVE TO FRESH AIR AND GET MEDICAL HELP." The text in the top panel, or header, must have letter heights of at least 0.12 inches, and all other text in the label must have text whose uppercase letters measure at least 0.1 inches in height.

(3) Comply with section 8 of PGMA G300-2018.

§ 1241.4 Prohibited stockpiling.

(a) *Prohibited acts*. Manufacturers and importers of portable generators shall not manufacture or import portable generators that do not comply with the requirements of this part in any 1-month period between [**DATE OF PUBLICATION OF FINAL RULE**] and [**EFFECTIVE DATE OF FINAL RULE**] at a rate that is greater than 120 percent of the rate at

which they manufactured or imported portable generators during the base period for the manufacturer or importer.

(b) *Base period.* The base period for portable generators is the average monthly manufacture or import volume for any continuous 180-day period within the last 12 months immediately preceding the month of promulgation of the final rule.

§ 1241.5 Findings.

(a) *General.* The CPSA requires the Commission to make certain findings when issuing a consumer product safety standard. 15 U.S.C. 2058(f). This section discusses support for those findings.

(b) *Degree and Nature of the Risk of Injury.* As of May 10, 2022, there were at least 1,332 deaths involving portable generators from 2004 through 2021, or an average of about 74 annually. Because death certificate data often have a lag time of around two to three years from the date of reporting to CPSC, the actual number of incidents for 2020 and, 2021 is likely higher. From 2004 through 2021, there were a total of 17,569 nonfatal CO poisonings involving portable generators that were treated in hospital emergency departments (about 976 annually); 7,308 hospital admissions (an average of 406 per year); and 52,782 medically attended injuries treated in other settings (an estimated 2,932 per year).

(c) *Number of Consumer Products Subject to the Rule*

In 2021, there were approximately 1,355 individual models for sale in the U.S. There were an estimated 2.1 million units sold in 2021.

(d) *Need of the Public for the Products and Probable Effect on Utility, Cost, and Availability of the Product*

(1) The portable generators within the scope of this proposed rule are commonly purchased by household consumers, particularly to provide electrical power during emergencies (such as power outages caused by storms); when power to the home has been shut off or it is needed at locations around or away from the home that lack access; and for recreational activities such as camping. Built-in wheels or optional wheel kits are often available for heavier, more powerful units (*e.g.*, those with 3 kW power ratings or more).

(2) The proposed rule's emission requirement may improve portable generator's fuel efficiency, as well as other characteristics such as ease of starting, altitude compensation, fuel adaptability, power output, reliability, and engine life; features that would likely increase the utility of the generator to the consumer in a meaningful way. In addition to this, safer portable generators from the implementation of the emissions and sensor/shutoff requirements would mitigate the anxiety of operating a hazardous product, and hence improve consumer utility as well. Conversely, consumer utility may decrease as a result of potential consumer behavioral adaption to a safer product that could lessen the attention paid to CO safety.

(3) The proposed rule would increase the undiscounted cost of redesigning, testing, and manufacturing portable generators by an average of $53.38. About three fifths of the cost increase would be transferred to consumers through price increases. The cost increase represents slightly more than 5 percent of the average price of a portable generator, of which more than 3 percent would be transferred to consumers. This transfer would increase the average price per portable generator from about $1,000 to $1,034. The quantity of portable generators demanded by consumers would decrease as a result of this price increase by less than 2 percent. Nevertheless, except for potential shortages associated with the inability of manufacturers to comply with the requirements of the rule prior to the effective date, it is unlikely that the rule has

any significant impact on the availability of the product to consumers. The potential transitional shortages would likely last only for a brief period of time, and would be alleviated as manufacturers become increasingly compliant with the proposed rule.

(e) *Any Means to Achieve the Objective of the Proposed Rule, While Minimizing Adverse Effects on Competition and Manufacturing.* (1) The rule achieves the objective of addressing acute CO poisoning hazards from portable generators while minimizing the effect on competition and manufacturing. The rule is largely based on requirements in two existing voluntary standards, and manufacturers are generally aware of the requirements. At least one manufacturer already complies with the main requirements of the rule, and has done so cost-effectively. The rule would apply to all manufacturers and importers of portable generators, so its economic impacts should not be highly burdensome for any particular manufacturer or importer. Additionally, manufacturers can transfer some, or all, of the increased production cost to consumers through price increases. Finally, the regulatory flexibility analysis concluded that only one small business is likely to be significantly impacted by the implementation of the rule. (2) The Commission considered alternatives to the rule to minimize impacts on competition and manufacturing including: (1) implementing the proposed rule without the emission requirements and shutoff requirement levels from UL 2201; (2) relying on the voluntary adoption of the proposed rule requirements into UL 2201 or PGMA G300; (3) issuing a rule that relies on either UL 2201 or PGMA G300 as currently written; (4) not issuing a rule and continue to conduct information and education campaigns; and (5) taking no action. The Commission determines that none of these alternatives would adequately reduce the risk of deaths and injuries associated with the acute CO poisoning hazard associated with portable generators that the rule addresses.

The rule is expected to generate more net societal benefits (benefits minus costs) than any of these alternatives.

(f) *Unreasonable Risk.*

(1) Based on the data from the reports that were entered in CPSC's databases as of May 10, 2022, there have been at least 1,332 deaths for years 2004 through 2021.

(2) Based on data from the National Electronic Injury Surveillance System, for the 18-year period from 2004 through 2021 there were at least 17,569 CO injuries associated with portable generators that were treated in emergency departments (ED) in which the patient was subsequently released without being admitted, and 5,727 injuries that required hospitalization after the ED.

(3) Based on data from CPSC's Injury Cost Model (ICM), for the years 2004 through 2021, there were an estimated 1,580 injuries that resulted in direct hospital admissions and 52,782 injuries resulted in a doctor's or clinic's visit. Combined with the NEISS estimates, there were an estimated 77,658 nonfatal injuries that were treated in the same 18-year period.

(4) Data from the Centers for Disease Control and Prevention (CDC) provide a source of comparison of the relative risk of CO poisoning associated with portable generators. CDC estimates that at least 430 people die in the United States from accidental CO poisoning every year. These are deaths caused by CO from any source, including motor vehicles. The average number of generator-related consumer CO deaths per year in CPSC's databases for the three most recent years of complete data, years 2017 through 2019, is 85, which is nearly 20 percent of CDC's estimate.

(5) The Commission estimates that the rule would result in aggregate net benefits of about $897.06 million annually, discounted at 3 percent. The Commission estimates that the net

benefits on a per-unit basis, when discounted at 3 percent, are $233.99. These net benefits per product represent roughly 23 percent of the average price of a portable generator, whereas total unit costs discounted at 3 percent are less than 4 percent of the average price. The Commission concludes that portable generators pose an unreasonable risk of injury and finds that the rule, including its effective date, are reasonably necessary to reduce the unreasonable risk of injury.

(g) *Public Interest.* The rule addresses an unreasonable risk of acute CO poisoning associated with portable generators. Adherence to the requirements of the proposed rule would reduce deaths and injuries from portable generator acute CO poisoning; thus, the rule is in the public interest.

(h) *Voluntary Standards*

(1) Under section 9(f)(3)(D) of the CPSA, if a voluntary standard addressing the risk of injury has been adopted and implemented, then, in order to proceed with rulemaking, the Commission must find either that: the voluntary standard is not likely to eliminate or adequately reduce the risk of injury, or substantial compliance with the voluntary standard is unlikely.

(2) There are two voluntary standards that address the risk of acute CO poisoning from portable generators: UL 2201, *Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition* ("UL 2201") and ANSI/PGMA G300-2018 (Errata Update), *Safety and Performance of Portable Generators* ("PGMA G300").

(3) Based on information provided by manufacturers and in market research materials, the Commission estimates a 30 percent compliance rate with PGMA G300's sensor and shutoff requirements. One sixth of those PGMA-compliant units (or 5 percent of the total) are estimated to also be compliant with the emissions requirements of UL 2201. In addition, the CO hazard mitigation requirements have been included in both standards since 2018, approximately 5 years

ago, yet the number of fatalities since then have not only not abated but appear to be increasing. The Commission concludes that compliance in the marketplace with either voluntary standard is not substantial, and substantial compliance is unlikely in the future.

(4) The Commission finds that the CO emission rate requirements and CO shutoff levels from UL 2201 are extremely effective in reducing deaths and injuries associated with acute CO poisoning from portable generators in simulations. The Commission concludes that these requirements are not adequate without additional requirements that ensure the durability, reliability and functionality of the CO shutoff system, and requirements pertaining to CO shutoff notification and labeling. Therefore, the rule incorporates PGMA G300's CO shutoff test method, and requirements from PGMA G300 specifying aspects of the shutoff system's construction, ability to self-monitor, and tamper resistance, and labeling, with modifications that are necessary to ensure the effectiveness of these requirements.

(i) *Reasonable Relationship of Benefits to Costs* (1) The rule would impose the following quantifiable costs: (a) increased variable costs of producing portable generators with reduced CO emission rates and CO sensors with shutoff capabilities; (b) one-time conversion costs of redesigning existing portable generator models, modifying manufacturing operations, and the recurrent testing costs to validate compliance of each new model with the proposed standard; (c) sensor replacement costs to consumers for failed CO sensors or sensors that have reached end of life; and (d) deadweight loss caused by price increases resulting from increased manufacturing costs. The Commission performed a 30-year prospective cost assessment (2024-2053) of these four cost categories and estimated the total annualized cost from the proposed rule to be $148.94 million, discounted at 3 percent. The Commission estimated the costs per portable generator to be $38.85, discounted at 3 percent.

(2) The Commission also conducted a benefits assessment of the rule. The benefits assessment accounted for the prevention of deaths and injuries from introducing compliant portable generators, which the Commission monetized using the value of statistical life for deaths and estimates of the cost per type of injury from the CPSC's Injury Cost Model. Over the 30-year study period, the Commission estimated the rule would prevent 2,148 deaths (nearly 72 deaths per year) and 126,377 injuries (roughly 4,213 injuries per year). The total annualized benefits from the rule are $1,046 million, discounted at 3 percent. The Commission estimates the per-unit benefits from the rule to be $272.84, discounted at 3 percent.

(3) The estimated benefits of the rule far exceed its estimated costs. The Commission calculates net benefits (benefits less costs) to be $897.06 million on an annualized basis, discounted at 3 percent.[54] The net benefits on per-unit basis are $233.99, discounted at 3 percent. Overall, the rule has a benefit-cost ratio of 7.02; that is, for every $1 in direct cost to consumers and manufacturers, the proposed rule generates $7.02 in benefits from mitigated deaths and injuries.

(j) *Least-Burdensome Requirement that Would Adequately Reduce the Risk of Injury*. The Commission considered five alternatives to the rule including: (1) implementing the rule without the emission requirements and shutoff requirement levels from UL 2201; (2) relying on voluntary adoption of the rule requirements into UL 2201 or PGMA G300; (3) issuing a rule that relies on either UL 2201 or PGMA G300 as currently written; (4) not issuing a rule and continue to conduct information and education campaigns; and (5) taking no action. Although most of these alternatives may be a less burdensome alternative to the rule, the Commission determines

[54] Over the 30-year period, net benefits reach $17.58 billion, discounted at 3 percent.

that none of the less burdensome alternatives would adequately reduce the risk of deaths and injuries associated with portable generators that is addressed in the rule.

§ 1241.6 Standards Incorporated by Reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. This material is available for inspection at the U.S. Consumer Product Safety Commission and at the National Archives and Records Administration (NARA). Contact the U.S. Consumer Product Safety Commission at: Office of the Secretary, U.S. Consumer Product Safety Commission, 4330 East West Highway, Bethesda, MD 20814, telephone (301) 504-7479, e-mail cpsc-os@cpsc.gov, and is available from the sources listed below. For information on the availability of this material at NARA, email fr.inspection@nara.gov, or go to: www.archives.gov/federal-register/cfr/ibr-locations.html.

(b) Portable Generator Manufacturers' Association, 1300 Summer Avenue, Cleveland, OH 44115-2851; phone: 216.241.7333; e-mail: pgma@pgmaonline.com; www.pgmaonline.com. ANSI/PGMA G300-2018 (Errata Update) *Safety and Performance of Portable Generators*, approved [DATE]; IBR approved for [SECTIONS]. A read-only copy is available at www.pgmaonline.com/pdf/ANSI_PGMAG300-2018(ErrataUpdateApril2020).pdf.

(c) Underwriters Laboratories, 1850 M St. NW STE 1000, Washington, DC 20036; 202.296.7840; www.ul.com. UL 2201, 2nd Edition, *Standard for Carbon Monoxide (CO) Emission Rate of Portable Generators,* approved January 24, 2018; IBR approved for [SECTIONS]. A read-only copy is available at www.shopulstandards.com/ProductDetail.aspx?UniqueKey=33821, or it can be purchased at www.shopulstandards.com.

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Secretary, Consumer Product Safety Commission

United States
Consumer Product Safety Commission

Staff Briefing Package

Draft Proposed Rule for Portable Generators

January 28, 2023

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This report was prepared by the CPSC staff. It has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

Executive Summary

As of May 10, 2022, the U.S. Consumer Product Safety Commission (CPSC) had reports of at least 1,332 carbon monoxide (CO) poisoning deaths of consumers associated with engine-driven portable generators occurring between 2004 through 2021. While data collection is ongoing, the number of CO deaths caused by portable generators in 2020 is likely to exceed the highest number of annual deaths that was reported in any prior year (103 in 2005). Staff estimates 77,658 medically attended nonfatal CO injuries of consumers from generators also occurred from 2004 through 2021.

CO is a colorless, odorless, and poisonous gas produced by the incomplete combustion of fuel in any fuel-burning product. When inhaled, CO rapidly enters the bloodstream through the lungs and effectively displaces oxygen from red blood cells, forming carboxyhemoglobin (COHb). Elevated COHb levels cause serious injuries and death.

The CO emission rates of almost all engine-driven portable generators are extremely high, on the order of hundreds or greater times the CO emission rates of cars. This means death can occur relatively quickly when the generator is used in enclosed or partially enclosed spaces or even when the generator is operated outdoors such that some of the exhaust flows indoors.

In 2006, the Commission published an advance notice of proposed rulemaking (ANPR) to determine whether there may be an unreasonable risk of injury and death associated with CO from engine-driven portable generators.[1] The ANPR began a rulemaking proceeding under the Consumer Product Safety Act (CPSA). In 2016, the Commission published a notice of proposed rulemaking (NPR) on engine-driven portable generators that proposed CO emission rate requirements for portable generators based on four different categories of engine sizes (2016 NPR).[2] Staff estimated that the proposed emission rates represented a rate reduction of approximately 75 percent for the smallest portable generators to approximately 90 percent for the largest portable generators.

In 2018, two voluntary standards groups published new editions of their voluntary standards that included requirements intended to address the acute CO poisoning hazard from portable generators: Underwriters Laboratories' (UL) UL 2201, *Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition* and the Portable Generator Manufacturers Association's (PGMA) PGMA G300, *ANSI/PGMA G300-2018 Safety and Performance of Portable Generators* (UL 2201 and PGMA G300, respectively).[3]

UL 2201 requires the generator to limit its weighted CO emission rate to a maximum of 150 grams per hour (g/h). Staff estimates the 150 g/h emission rate represents a reduction of almost all current generators' CO emission rates by approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule. UL 2201 also requires the generator to shut off when the CO

[1] 71 Fed. Reg 74472 (Dec. 12, 2006).

[2] 81 Fed. Reg. 83556 (Nov. 21, 2016).

[3] UL 2201 is available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=33821 and PGMA G300 is available for free digital view at Safety and Performance of Portable Generators (pgmaonline.com)

concentration measured above the generator reaches an instantaneous 400 parts per million by volume (ppmv) or before exceeding 150 ppmv[4] for a 10-minute rolling average.

PGMA G300 does not have a CO emission rate requirement but requires the generator to shut off before the CO concentration measured above the generator exceeds an instantaneous 800 ppmv or 400 ppmv for a 10-minute rolling average. PGMA G300 has additional requirements for tamper resistance, self-monitoring system requirements, and construction requirements to address the durability, reliability, and functionality of the CO shutoff system, as well as requirements for notification and labeling regarding the CO shutoff system.

Staff assessed the effectiveness of the CO hazard-mitigation requirements in the voluntary standards by working with staff of the National Institute for Standards and Technology (NIST) to simulate the scenarios of 511 actual CO deaths caused by engine-driven portable generators in CPSC's databases using an indoor air quality modeling program. Specifically, the analysis assessed the effectiveness of the CO emission rate and shut off requirements of UL 2201 and the shut off requirements of PGMA G300. The results from this effectiveness analysis showed that under simulated conditions, generators compliant with the CO emission rate and CO shutoff requirements of UL 2201 standard would avert nearly all 511 deaths, or nearly 100 percent of the deaths, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. Generators compliant with the CO shutoff requirements of PGMA G300 would avert about 87 percent of the 511 deaths, resulting in 69 deaths, with 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released.

Staff also assessed whether there is or likely to be substantial compliance with either of the two voluntary standards. Staff found that manufacturers are not substantially in compliance with either voluntary standard, and staff does not anticipate compliance to be substantial in the future. Both standards adopted their CO hazard mitigation requirements in 2018, approximately 5 years ago, yet the number of fatalities since then have not only not abated but appear to be increasing, leading staff to conclude that compliance in the marketplace is not substantial.

Staff has developed an updated draft proposed rule, presented in this draft supplemental notice of proposed rulemaking (SNPR), because staff concludes that the current draft proposed rule requirements, based on requirements from UL 2201 and PGMA G300, are likely to reduce the risk of CO injuries and deaths to a greater degree than those in the 2016 NPR. This combination of requirements would build on industry's own standards and likely address nearly all known fatalities associated with portable generators. Moreover, the SNPR has added requirements related to shutoff, which have been promoted by PGMA and has some degree of industry acceptance.

As discussed in this briefing package, the draft proposed rule is based largely on provisions from the voluntary standards that staff concludes will effectively reduce the risk of acute CO poisoning associated with engine-driven portable generators, with modifications, as necessary, to ensure the risk is adequately addressed. The draft proposed rule no longer divides portable generators into different categories based on the respective engine sizes, as was done in the 2016 NPR; but it would instead impose the same requirements for generators as a single class, as is the case with each of the voluntary standards. The draft proposed rule incorporates the CO emission rate limit of UL 2201 that limits CO emissions to a maximum of 150 g/h. It also incorporates the

[4] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

shutoff concentrations from UL 2201 that require the generator to shut off when the CO concentration measured above the generator reaches an instantaneous 400 ppmv or 150 ppmv for a 10-minute rolling average. Staff's effectiveness analysis demonstrated that the combination of the CO emission rate and shutoff performance requirements can be extremely effective in addressing the acute CO poisoning risk associated with portable generators.

To ensure that these simulated performance requirements are effective in real-world scenarios, however, the CO shutoff system needs to be reliable, functional, and durable. The draft proposed rule, therefore, incorporates test methods from UL 2201 to verify conformance to the CO emission rate requirement. The draft proposed rule also incorporates the test method from PGMA G300 to verify conformance to the CO shutoff requirements, with modifications staff assesses are necessary to ensure the effectiveness of the test method. The draft proposed rule also includes requirements for maintaining functionality (including tamper resistance), self-monitoring system requirements, and construction requirements to address the durability, reliability, and functionality of the CO shutoff system, and a notification and labeling requirement, all of which are based on PGMA G300.

The CPSA provides that the effective date of a consumer product safety rule must be at least 30 days, and no more than 180 days, after promulgation of the rule, unless the Commission finds good cause to shorten or extend the effective date. Staff recommends a draft proposed rule effective date of 180 days after the publication date of a final rule in the *Federal Register*, and staff seeks public comment on the feasibility of the proposed effective date.

Based on staff's preliminary regulatory assessment, staff estimates the draft proposed rule would avert 2,148 deaths (nearly 72 deaths per year) and 126,387 injuries (roughly 4,213 injuries per year) over 30 years. Overall, the draft proposed rule has net benefits (benefits over and above costs) of $897.06 million on an annualized basis at a 3 percent discount rate, and for every $1 in direct cost to consumers and manufacturers, the draft proposed rule generates $7.02 in benefits from mitigated deaths and injuries.

The draft proposed rule is likely to have a significant adverse economic impact on only one of four identified small manufacturers of portable generators. It is unlikely to have a significant direct impact on small portable generator importers.

To reduce the risk of injury and death associated with acute CO poisoning from portable generators, staff recommends that the Commission approve publication of the staff's draft proposed rule.

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Table of Contents

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Briefing Memorandum

TO: The Commission
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Austin C. Schlick, General Counsel
Jason Levine, Executive Director
DeWane Ray, Deputy Executive Director for Operations

DATE: January 28, 2023

FROM: Duane E. Boniface, Assistant Executive Director,
Office of Hazard Identification and Reduction

Janet Buyer, Project Manager
Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

SUBJECT: Draft Supplementary Notice of Proposed Rulemaking: Safety Standard for Portable Generators

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I. Introduction

This memorandum, prepared by staff of the U.S. Consumer Product Safety Commission (CPSC), explains staff's draft proposed rule to address the carbon monoxide (CO) poisoning hazard associated with engine-driven portable generators and summarizes staff's analyses that support the draft proposed rule. This memorandum supports staff's recommendation that the Commission publish a supplemental notice of proposed rulemaking (SNPR) pursuant to sections 7 and 9 of the Consumer Product Safety Act (CPSA).

II. Background

A. Portable Generator Description

An engine-driven portable generator is a consumer product that converts chemical energy from the fuel powering the engine to rotational energy, which, in turn, is converted to electrical power. The engine can be fueled by gasoline, liquified propane gas (LPG), natural gas (NG), or diesel fuel. The generator has a receptacle panel that consumers use to connect appliances, power tools, or other electrical loads to the generator via a plug connection. These generators are designed for portability, to be carried, pulled, or pushed by a person.

Manufacturers and retailers advertise portable generators by many different features, but one of the primary features is the amount of electrical power the generator can provide continuously. The industry commonly refers to this as "rated power," "rated wattage," or "running wattage," which ranges from less than 1,000 watts (1 kilowatt or 1 kW) to approximately 20 kW.[1]

B. Fatality and Injury Incident Data and Hazard Characteristics

1. Physiology and Health Impacts of CO Poisoning

CO is a colorless, odorless, poisonous gas formed during incomplete combustion of fossil fuels, which occurs in all fuel-burning products to varying degrees.[2] For engines, such as those used in portable generators, CO is emitted along with other exhaust gas constituents that have noxious odors. Initial CO poisoning effects on exposed persons result primarily from oxygen deprivation (hypoxia), due to compromised uptake, transport, and delivery of oxygen to cells by hemoglobin in the blood. This is because, compared to oxygen, CO has approximately a 250-fold higher likelihood to bind with hemoglobin. Thus, inhaled, CO rapidly enters the bloodstream through the lungs and effectively displaces oxygen from red blood cells, resulting in formation of carboxyhemoglobin (COHb). The COHb level reflects the percentage share of the body's total hemoglobin pool occupied by CO.[3] In modeled acute exposure scenarios, it serves as a useful measure of expected poisoning severity in a reference individual.[4] As shown in Table 1[5], elevated COHb levels cause serious injuries and death.

[1] The generator's rated power is generally a function of the horsepower or kilowatt rating of the engine, but there is no industry standard that relates the generator's rated power to the engine's rated power; nor is there any uniform way in which the generator's electrical output capacity is advertised as "rated."

[2] Incomplete combustion is a process that entails only partial burning of a fuel. CO is a byproduct from incomplete combustion of carbon.

[3] COHb is measured with a blood sample from the exposed person. Measured COHb levels are influenced by the timing of the COHb measurement, relative to cessation of the CO exposure, and by provision of any oxygen therapy in the intervening period.

[4] Inkster, Sandra, PhD, *A Comparison of the Carbon Monoxide (CO) Poisoning Risk Presented By A Commercially-Available Portable Gasoline-Powered Generator Versus A Prototype "Reduced CO Emissions" Generator, Based On Modeling Of Carboxyhemoglobin (COHb) Levels From Empirical CO Data,* U.S. Consumer Product Safety Commission, Bethesda, MD, August 13, 2012. (TAB G in the staff report *Technology Demonstration of a Prototype Low Carbon Monoxide Emission Portable Generator* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/staff%20report%20on%20technology%20demonstration.pdf (Docket ID CPSC-2006-0057-0002 in www.regulations.gov)

[5] Burton LE, (July 1, 1996) CPSC Health Sciences Memorandum, Toxicity from Low Level Human Exposure to Carbon Monoxide.

Table 1. Approximate Correlation Between Acute %COHb Levels and Symptoms in Healthy Adults

% COHb	Symptoms
<10	No perceptible ill effects (Some studies have reported adverse health effects in some cardiac patients at 2% to 5% COHb)
10 to 20	Mild headache, labored breathing, decreased exercise tolerance
20 to 30	Throbbing headache, mild nausea
30 to 40	Severe headache, dizziness, nausea, vomiting, cognitive impairment
40 to 50	Confusion, unconsciousness, coma, possible death
50 to 70	Coma, brain damage, seizures, death
>70	Typically fatal

For some individuals who survive serious prolonged COHb elevations, the resulting brain hypoxia, and any consequent associated damage, may ultimately result in the phenomenon of delayed neurological sequelae (DNS). DNS is typically manifested within a few days or weeks after apparent recovery from the initial CO exposure. Symptoms can include emotional instability, memory loss, dementia, psychosis, Parkinsonism, incontinence, blindness, hearing loss, paralysis, and peripheral neuropathy. Some symptoms of DNS may respond to hyperbaric oxygen (HBO) therapy or may resolve spontaneously within approximately a 2-year period. However, victims exhibiting the most severe symptoms, such as Parkinsonism, blindness, and paralysis, are often permanently affected.[6]

Consumers exposed to high CO emissions can experience a sudden, steep rise of COHb levels, leading them to experience a rapid onset of confusion, loss of muscular coordination, and loss of consciousness. This can occur so suddenly that they do not experience the milder CO poisoning symptoms associated with a low, or slowly rising, CO level that affords them the opportunity to recognize a hazardous situation is developing and take action to save themselves from further injury or death. The CO emission rates of the small engines that power almost all portable generators and other engine-driven tools is on the order of *hundreds or greater times* the CO emission rates of cars.[7] This means death can occur relatively quickly when the generator is used in enclosed or partially enclosed spaces or even when operated outdoors such that some of the exhaust flows indoors. It is important to note that the relationship between CO concentration and COHb is non-linear. This means that, for example, after a CO

[6] U.S. EPA, (2000) Air Quality Criteria for Carbon Monoxide, EPA 600/P-99/001F.

[7] The comparison depends on the size of the generator, the load on the generator, and the fuel efficiency of the car used for the comparison. A mid-size generator powering a moderate number of appliances emits approximately 1570 grams per hour (g/h) of CO and a large generator emits approximately 3030 g/h (see table 4 in *CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*, February 16, 2022. https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov) Published emission rates of idling cars from the 1990s show that they emitted approximately 2 to 5 grams per hour. (see Frey, H., et al., *On-Road Measurement of Vehicle Tailpipe Emissions Using a Portable Instrument*, Journal of the Air & Waste Management Association, Vol.53, August 2003.) Using these emission rates, the comparison equates to generators emitting hundreds to thousands of times more CO than the 1990s cars. Generators delivering a higher load emit more CO, and today's more fuel efficient cars emit less CO.

exposure profile has reached a peak and is decreasing, such as when a generator shuts off, the COHb will continue to rise for some time before COHb decreases.[8]

2. CO Fatalities from Portable Generators

CPSC staff publishes an annual report summarizing the in-scope[9] CO incidents captured in CPSC's databases that are associated with engine-driven generators and other engine-driven tools. Based on the data from the reports that were entered in CPSC's databases as of May 10, 2022, there have been at least 1,332 consumer deaths for years 2004 through 2021.[10,11] Figure 1 shows the number of reported deaths involving a generator for each of the years in this period. Data for the two most recent years, 2020 and 2021, are incomplete, because data collection is ongoing, and the death count most likely will increase in future reports.[12]

[8] This is exemplified in test results presented in NIST Technical Note 2049 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Portable Generators with a CO Safety Shutoff Operating in a Test House*, available online at https://doi.org/10.6028/NIST.TN.2049. In the vast majority of the tests, the peak COHb levels were attained hours after the generator shut off.

[9] In-scope cases are unintentional, not work-related, non-fire CO poisoning deaths associated with a consumer product under the jurisdiction of the CPSC. Out-of-scope cases involve CO sources that are not under the jurisdiction of the CPSC under the CPSA (including motor vehicle exhaust cases), fire or smoke-related exposures, or intentional CO poisonings. Examples of out-of-scope cases include poisonings due to gases other than CO (*i.e.*, natural gas, ammonia, butane), poisonings from motor vehicle exhaust, or generators permanently installed in boats or recreational vehicles, or work-related exposures.

[10] Death data for years 2004 through 2010 are from the following report, with an additional death included in 2004 that was reported in the NEISS data but was not previously accounted for: Hnatov, M.V., *Generators Involved in Fatal Incidents, by Generator Category, 2004-2014*, U.S. U.S. Consumer Product Safety Commission, Bethesda, MD, September 2016. (TAB B in https://www.cpsc.gov/s3fs-public/Proposed-Rule-Safety-Standard-for-Portable-Generators-October-5-2016.pdf; Document ID CPSC-2006-0057-0032 in www.regulations.gov).

[11] Death data for years 2011 through 2021 are from the following report, with 5 deaths from 3 incidents in 2011 excluded because they involved stationary generators, which are outside the scope of the draft proposed rule: Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2022 https://www.cpsc.gov/content/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021 (Document ID CPSC-2006-0057-0108 in www.regulations.gov)

[12] For example, in staff's annual report covering the years 2010 through 2020, the numbers of deaths entered in CPSC's databases as of May 17, 2021 for the years 2019 and 2020 were 89 and 54, respectively. The deaths in each of these years increased to 95 and 103, respectively, in the June 2022 report referenced in footnote 11, when the data was pulled almost exactly one year later. See https://www.cpsc.gov/content/Generators-and-OEDT-CO-Poisoning-Fatalities-Report-2021

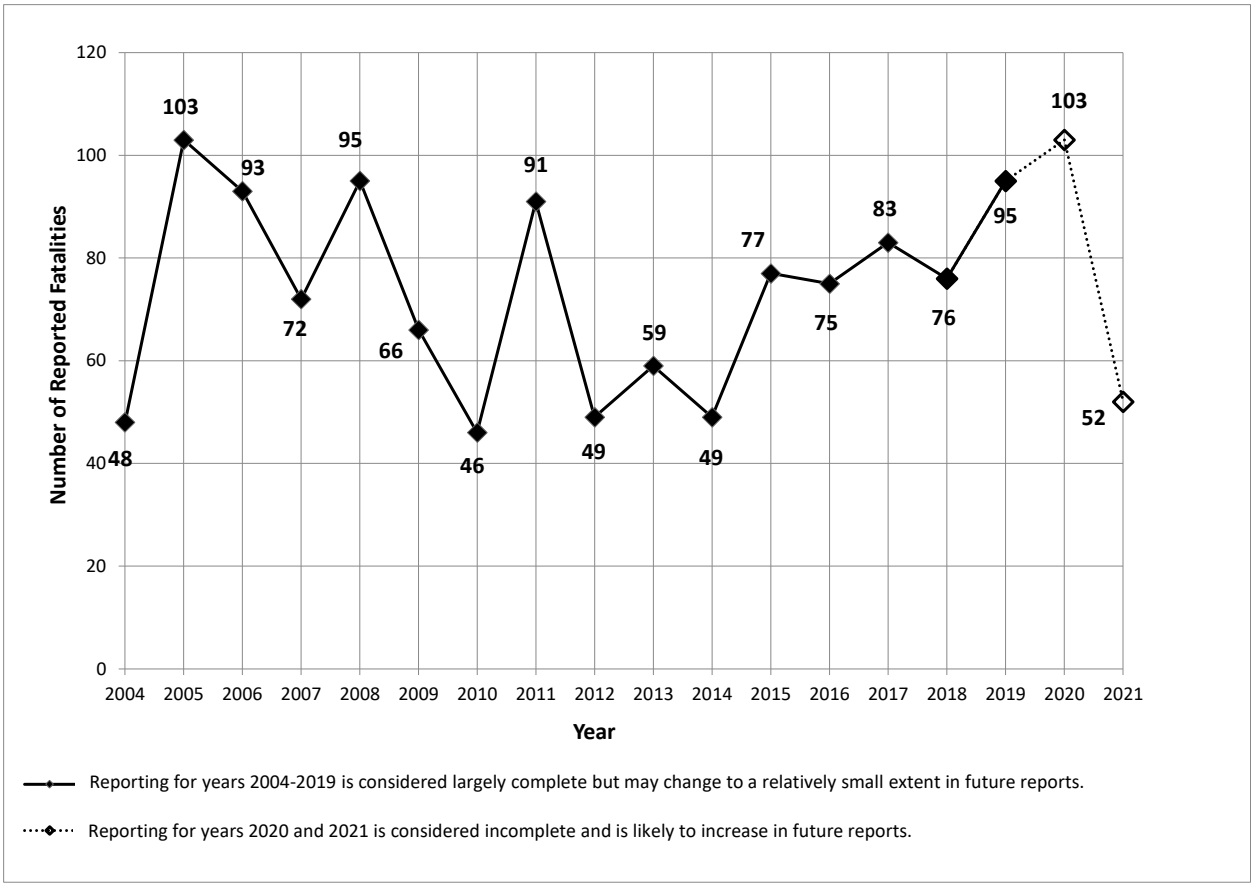

Figure 1. Number Of Reported Non-Fire CO Poisoning Deaths Involving Generators in CPSC Databases as of May 10, 2022, by Year, 2004-2021

It is noteworthy that the Centers for Disease Control and Prevention (CDC) estimates that at least 430 people die in the United States from accidental CO poisoning every year.[13] These are deaths caused by CO from any source, including motor vehicles. The average number of generator-related consumer CO deaths per year in CPSC's databases for the most recent 3 years of complete data (years 2017 through 2019) is 85, which is nearly 20 percent of the CDC's estimate.

3. Hazard Patterns of Fatal Incidents

To gather more detailed information about the incidents and the products in use to characterize hazard patterns, CPSC Field Staff conducted in-depth investigations (IDI) on nearly all 1,332

[13] https://www.cdc.gov/dotw/carbonmonoxide/index.html

deaths shown in Figure 1. Based on two annual reports covering the 18-year period[14,15], the following are general descriptions of the hazard patterns for those incidents:

- More than 2/3 of all generator CO deaths reported to CPSC occurred in a fixed-structure home location, which includes houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage.[16] Of these deaths:
  - More than one-third occurred when the generator was operated in the living space[17] of the home.
  - Approximately one-quarter occurred when the generator was in the attached garage or partially enclosed carport.
  - Approximately one-quarter occurred when the generator was in the basement or crawlspace.
  - A relatively small number occurred when the generator was operated outside of the home location.
- The remaining deaths that did not occur at fixed-structure home locations occurred at a variety of locations, such as detached garages and sheds, travel trailers, RVs, boats, and vehicles, when the IDI identified a location.[18]
- Almost half of the incidents occurred among the coldest months of the year in the United States (November through February). Many of the fatalities over these months can be directly related to the use of generators during power outages caused by winter weather conditions, such as ice or snowstorms.
- Nearly one-third of the incidents occurred in the months of March, April, September, and October, which are typical months with transitional weather between summer and winter weather. These can be directly related to the use of generators during power outages caused by hurricanes and tropical storms, many occurring in September, and to a lesser extent, in October.

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[14] Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2022. https://www.cpsc.gov/content/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021 (Document ID CPSC-2006-0057-0108 in www.regulations.gov).

[15] Hnatov, M.V., *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 2004-2014*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2015. https://www.cpsc.gov/content/incidents-deaths-and-depth-investigations-associated-non-fire-carbon-monoxide-engine-1 (Document ID CPSC-2006-0057-0026 in www.regulations.gov).

[16] Travel trailers, campers, and recreational vehicles (RV) are not included in this classification; nor are external structures at the home, such as detached garages or sheds.

[17] Used here, living space includes all rooms, closets, doorways, and unidentified areas inside a home, except for basements, which are treated as a separate category.

[18] All of the incidents that occurred with travel trailers, RVs, boats, and vehicles involved portable generators that consumers placed in, on, or around them, not generators that were affixed to them by the manufacturer.

- Almost one-quarter of the fatalities happened in multiple-fatality incidents, some involving entire families.

- A number of IDIs reported that the consumer bought or rented the generator just before the incident. More recently, between August 2020 and September 2021, at least four fatal incidents that caused seven consumer CO deaths reportedly involved a newly purchased or rented generator. One of these incidents, resulting in three fatalities, was reported to involve a generator certified to the U.S. voluntary standard ANSI/PGMA G300-2018.[19] This voluntary standard is discussed later in this memorandum, and this incident is discussed further in TAB D.

4. CPSC Estimates of CO Injuries from Portable Generators

One of CPSC's databases is the National Electronic Injury Surveillance System (NEISS), which is a national probability sample of approximately 100 hospitals in the United States and its territories, that is used by staff to make national injury estimates associated with consumer products. Based on NEISS, staff estimates that for the 18-year period from 2004 through 2021, there were 17,569 CO injuries associated with portable generators that were treated in emergency departments (ED) and the patient was subsequently released without being admitted, and 5,727 injuries that required hospitalization after the ED. (See TAB A.) Staff cautions that these estimates should be considered underestimates because of the following:

(1) Physicians have noted difficulty in correctly diagnosing these injuries.[20] CO poisoning may mimic many nonfatal conditions, including alcohol or drug intoxication, psychiatric disorders, flulike illnesses, and other conditions that can lead to misdiagnosis. Measurement of COHb levels in the victim's blood, which could confirm the poisoning, can also be confounded, based on the time elapsed and any breathing treatment administered that can lower counts before measurement.

(2) Staff is aware that in some incidents reported in the IDIs, first responders transported severely poisoned victims found at the scene directly to a medical facility with a hyperbaric oxygen (HBO) chamber for treatment, rather than to a hospital ED.

In consideration of non-ED medically treated injuries, including those mentioned above, in addition to the estimate of generator-related CO injuries seen in hospital EDs, staff also estimated CO injuries using CPSC's Injury Cost Model (ICM). The ICM estimates injuries treated in locations other than hospital EDs. Specifically, the ICM uses empirical relationships between the characteristics of injuries and victims in cases initially treated in hospital EDs and those initially treated in other medical settings (*e.g.*, physicians' offices, ambulatory care centers, emergency medical clinics), based primarily on data from the Medical Expenditure Panel Survey,[21] to estimate the number of medically attended injuries that were treated outside of hospital EDs. The ICM also analyzes data from the Nationwide Inpatient Sample of the

[19] Redacted IDI in document ID number CPSC-2006-0057-0110 in www.regulations.gov.

[20] Aniol, M. J. *Carbon Monoxide Toxicity: The Difficulty in Diagnosing This Leading Cause of Poisoning.* Can Fam Physician. 1992 2123-2134, 2174.

[21] The Medical Expenditure Panel Survey is a set of large-scale surveys of families and individuals, their medical providers, and employers across the United States. https://www.meps.ahrq.gov/mepsweb/

Healthcare Cost and Utilization Project[22] to project the number of direct hospital admissions bypassing the hospital EDs. According to the ICM, for the years 2004 through 2021, staff estimates 1,580 injuries resulted in direct hospital admissions and 52,782 injuries resulted in a doctor's or clinic's visit. Combined with the NEISS estimates stated previously, this means that there were an estimated 77,658 nonfatal injuries that were treated in the same 18-year period. (See TAB B.)

The details of the hazard patterns associated with these injuries are largely unknown, because the NEISS reports, drawn from medical records, do not contain extensive narratives regarding what led to the need for medical treatment. However, given that CPSC has reports of at least 79 deaths in the 18-year period that reported the generator was being operated outside (see TAB A), it is reasonable to assume that at least some of the injuries from the NEISS database also occurred when the generator was operated outside. Furthermore, staff recently conducted a case study that demonstrates this scenario is not a rare occurrence. In this case study, staff analyzed incidents of CO from generators operating outside that resulted in CO migrating into consumers' homes in the greater New Orleans area following widespread power outages caused by Hurricane Ida in fall 2021. (See TAB D). From the information staff has received from responding fire departments, at least 63 homes that had CO inside after Ida struck, and 911 was called, the incidents reportedly were due to a portable generator operating outside.[23] Residents in six of these homes felt ill with one or more CO poisoning symptoms, and ambulances transported 10 people to the hospital. One was admitted overnight; the treatment for the other nine is unknown.

For the injury estimates, staff assumed that the injuries occurred in a similar distribution of scenarios as those for the 511 deaths replicated for staff's voluntary standards' effectiveness analysis (discussed in section II.D.3). Only 2 percent of deaths included in staff's voluntary standards' effectiveness analysis (8 out of 511) involved a generator running outside. Since CPSC's death data show 6 percent (79 out of 1332 deaths) occurred with the generator running outside, this scenario is underrepresented in the simulations; therefore, the injury estimates may be underestimates. Nevertheless, the estimated 77,658 injuries yield a ratio of approximately 58 estimated injuries to each death in CPSC's databases in this 18-year period.

[22] The Nationwide Inpatient Sample of the Healthcare Utilization Project is the largest publicly available, all-payer inpatient healthcare database designed to produce U.S. regional and national estimates of inpatient utilization, access, cost, quality, and outcomes. https://www.hcup-us.ahrq.gov/nisoverview.jsp

[23] One hundred-three homes had CO exposures from stationary generators. Thirty-six homes had CO exposures from either a stationary or portable generator, but the details provided in the fire department report were insufficient for staff to ascertain which type, and field staff was unable to reach a resident to find out. (In many of these, the fire department recommended that the generator be moved or not be turned on until it was moved). And for 51 homes, the fire department report did not document the source of CO, but the fire department provided the report to CPSC in response to a request for generator-related CO incidents, and field staff was unable to reach a resident to learn more. (Various fire departments communicated to CPSC field investigators that due to the chaotic situation after Hurricane Ida struck and the large number of calls to 911, some fire departments were able to keep up by only minimally documenting each incident.) Of these latter 87 homes involving an unknown generator type, eight homes had residents who felt ill with one or more CO poisoning symptoms, and ambulances transported eight people to the hospital. It is unknown to staff if any of the eight were hospitalized. One incoherent person, who the fire department removed from their house, refused aid from the ambulance.

Staff recommends that the Commission seek information about CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors.

5. Compliance Activities

Based on a search of recall data from the past 20 years, there were no portable generator recalls for CO poisoning hazards.

C. Background of Rulemaking Activity

In 2006, staff delivered a briefing package[24] and briefed the Commission[25] on staff's review of portable generator safety. The Commission subsequently published an advance notice of proposed rulemaking (ANPR) to consider whether there may be an unreasonable risk of injury and death from CO poisoning associated with portable generators.[26] The ANPR began a rulemaking proceeding under the CPSA.

Following publication of the ANPR, CPSC contracted with the University of Alabama (UA) to conduct a low CO emission prototype generator technology development and durability demonstration and contracted with the National Institute for Standards and Technology (NIST) to conduct comparative testing of an unmodified carbureted generator and prototype generators in an attached garage of a test house facility and to perform indoor air quality (IAQ) modeling. CPSC staff published a report regarding the results of the UA technology demonstration and NIST's test results.[27] NIST published a report concerning the results of the comparative testing of generators as well as IAQ modeling they performed using their test results.[28]

In October 2016, staff delivered to the Commission a draft proposed rule to address the CO poisoning hazard associated with portable generators.[29] The draft proposed rule would have limited the CO emission rates of portable generators based on four different size categories. Staff estimates the proposed CO emission rates equated to reductions of approximately 75

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[24] *Portable Generators: Legal Memorandum and Staff Briefing Package for ANPR* https://www.cpsc.gov/s3fs-public/pdfs/foia_PortableGenerators.pdf

[25] *Staff Review of Portable Generator Safety* https://www.cpsc.gov/s3fs-public/pdfs/foia_portgenstaffrev.pdf

[26] Portable Generators; Advance Notice of Proposed Rulemaking; Request for Comments and Information, 71 FR 74472 (Dec. 12, 2006). (Document ID number CPSC-2006-0057-0001 in www.regulations.gov)

[27] *Technology Demonstration of a Prototype Low Carbon Monoxide Emission Portable Generator* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/staff%20report%20on%20technology%20demonstration.pdf (Document ID number CPSC-2006-0057-0002 in www.regulations.gov)

[28] *NIST Technical Note 1781; Modeling and Measuring the Effects of Portable Gasoline Powered Generator Exhaust on Indoor Carbon Monoxide Level* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/CPSC%20staff%20cover%20statement%20and%20NIST%20TN%201781.pdf

[29] *CPSC Staff Briefing Package for Notice of Proposed Rulemaking For Safety Standard For Carbon Monoxide Hazard For Portable Generators, October 5, 2016.* https://www.cpsc.gov/s3fs-public/Proposed-Rule-Safety-Standard-for-Portable-Generators-October-5-2016.pdf (Document ID CPSC-2006-0057-0032 in www.regulations.gov)

percent for the smallest generators to approximately 90 percent for the two largest-size categories, compared to the CO emission rates of almost all current generators.

The Commission voted to approve publication of the draft proposed rule, and on November 21, 2016, the Commission issued a notice of proposed rulemaking (NPR) that included a 75-day comment period.[30,31,32] Following a request for an extension, the Commission later approved the request to extend the comment period another 75 days.[33] The Commission also approved a notice of opportunity for oral presentation of comments, and this meeting for oral presentations was held on March 8, 2017.[34] TAB G contains a summary of significant comments received and staff's responses to these comments.

Following publication of the NPR, Underwriters Laboratories (UL) and the Portable Generator Manufacturers Association (PGMA) each published new editions of their voluntary standards that included CO hazard-mitigation requirements. UL published ANSI-approved UL 2201, *Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition*, on January 9, 2018 (UL 2201).[35] PGMA published ANSI-approved ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators*, on April 20, 2018 (PGMA G300).[36]

In 2019, the Commission announced the availability of, and sought comment on, a plan developed by CPSC staff and NIST staff to estimate the effectiveness of the CO-mitigation requirements in PGMA G300 and UL 2201, NIST Technical Note 2048, "Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators."[37] In August 2020, the Commission announced the availability of a memorandum documenting

[30] Commission Decisional Meeting Minutes, November 2, 2016.

[31] Notice of proposed rulemaking, *Safety Standard for Portable Generators*, 81 FR 83556, (Nov. 21, 2016.) https://www.federalregister.gov/documents/2016/11/21/2016-26962/safety-standard-for-portable-generators

[32] The comments and other documents related to the rulemaking are available in docket CPSC-2006-0057 in www.regulations.gov.

[33] Notice of proposed rulemaking; Extension of comment period for *Safety Standard for Portable Generators*, 81 FR 89888 (Dec. 13, 2016).

[34] *Portable Generators; Notice of Opportunity for Oral Presentation of Comments*, 82 FR 8907 (Feb. 1, 2017).

[35] *UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators*, *Second Edition*, Dated January 9, 2018. Available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=33821

[36] *ANSI/PGMA G300-2018 (Errata Update), Safety and Performance of Portable Generators*, available online at https://www.pgmaonline.com/pdf/ANSI_PGMAG300-2018(ErrataUpdateApril2020).pdf. On May 1, 2020, PGMA issued an erratum update to PGMA G300-2018 that changed the requirement for packaging marking from a logo to the following text or equivalent wording: "This product complies with the ANSI/PGMA G300-2018 standard."

[37] Notice of Availability: Plan to Evaluate CO Mitigation Requirements for Portable Generators, 84 FR 32729 (July 9, 2019). https://doi.org/10.6028/NIST.TN.2048

CPSC staff's revisions to NIST TN 2048 resulting from CPSC and NIST staffs' review of the comments and staff's resolution of the comments.[38,39]

In February 2022, CPSC staff reported its findings regarding the effectiveness of the CO mitigation requirements in UL 2201 and PGMA G300, "*CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*."[40]

D. Portable Generator Voluntary Standards' CO Hazard Mitigation Requirements

1. UL 2201

In 2002, UL convened a standards technical panel (STP) of stakeholders with varied interests and backgrounds to develop requirements for the first edition of their safety standard for portable generators, UL 2201. Staff participated in the STP and worked to develop requirements to address the CO poisoning hazard. In 2014, at staff's request[41], UL solicited to find stakeholders to serve on a task group (TG)[42] to develop a proposal for the STP's consideration that would address the CO hazard. This effort culminated on January 9, 2018, after the STP voted to approve, and UL published, the ANSI-approved[43] second edition of *UL 2201.* UL 2201 includes a requirement for a maximum weighted[44] CO emission rate of 150 g/h[45] and a requirement for the generator to shut off when the CO concentration, measured 1 foot above the centerline (the geometric center) of the top of the generator, registers either an instantaneous reading of 400 ppmv or before exceeding 150 ppmv for a 10-minute rolling

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[38] Notice of Availability: Revisions to the Plan Documented in NIST Technical Note 2048: Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators, 85 FR 52096 (Aug. 24, 2020).

[39] Staff memorandum https://www.cpsc.gov/s3fs-public/revisions-to-TN2048-and-comment-resolutions.pdf (Document ID CPSC-2006-0057-0106 in www.regulations.gov).

[40] https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov).

[41] Staff letter to UL https://www.cpsc.gov/s3fs-public/pdfs/blk_pdf_CPSCstafflettertoULdatedJan142014.pdf.

[42] UL email soliciting TG members https://www.cpsc.gov/s3fs-public/pdfs/blk_pdf_FormationofnewTaskGroupforDevelopmentofProposedRequirementstoAddressCOHazardAssociatedwithPortableGenerators.pdf

[43] American National Standards Institute (ANSI) is "a private, non-profit organization that administers and coordinates the U.S. voluntary standards and conformity assessment system. A voluntary consensus standard that is designated as ANSI-accredited is an "American National Standard (ANS) that is developed in accordance with the ANSI Essential Requirements: Due process requirements for American National Standards and subject to ANSI's neutral oversight and approval. These requirements are designed to ensure that development of American National Standards is a fair and responsive process that is open to all directly and materially interested parties." www.ansi.org

[44] The weighted CO emission rate is calculated from the emission rates that are measured while each of 6 different prescribed loads are applied to either the engine or the generator, multiplying each emission rate with a prescribed weight factor and then summing the product of weight factor and emission rate for each of the six loads.

[45] Staff estimates the 150 g/h emission rate represents a CO emission rate reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule compared to the emission rates of almost all current portable generators.

average. The standard provides the option of using one of two test procedures for verifying the CO emission rate, either testing with the engine installed in the generator assembly in the configuration when the consumer purchases it, or by testing the standalone engine in accordance the U.S. Environmental Protection Agency's (EPA) engine emission test procedure defined in Engine Testing Procedures, 40 CFR part 1065.[46] The standard includes a test method for verifying compliance with the CO shutoff requirements in which the generator is operated in a closed room and the room CO concentration is measured 1 foot above the top center of the generator. The generator must shut off when the CO measured above the generator meets the shutoff concentrations. Any product certified to UL 2201 after publication of the 2nd Edition on January 9, 2018, must meet the requirements of the 2nd Edition.

2. PGMA G300

The PGMA participated in the STP and the TG for UL 2201. In late 2016, PGMA's technical committee began developing CO hazard-mitigation requirements for its own standard, PGMA G300-2015, while continuing their participation on the STP and the TG for UL 2201. PGMA's efforts culminated on April 20, 2018, after a canvass committee of stakeholders with varied interests and backgrounds voted to approve, and PGMA published, the ANSI-approved 2018 edition of PGMA G300. PGMA G300 lacks a CO emission rate requirement but includes a requirement for generators to be equipped with an onboard CO sensor that is certified to requirements in the U.S. voluntary standard for residential CO alarms, *UL 2034, Standard for Safety, Single and Multiple Station Carbon Monoxide Alarms*.[47] The CO sensor, when tested to the requirements in the standard, must shut off the generator before the CO concentration, when measured at a location 1 to 2 inches above the approximate center of the portable generator's top surface, exceeds either an instantaneous reading of 800 ppmv or 400 ppmv for a 10 minute rolling average of CO. A rolling average is a calculation averaging data over an interval of time that changes its initial point and end point as specified by the duration of the time interval. PGMA G300-2018 also requires notification after a shutoff event. This notification is required to be "a red indication," but the type of indicator is not specified (*e.g.*, the indication is not required to be a light). The standard allows, but does not require, the indication to be "blinking, with a maximum period of 2 seconds." The indication must remain for a minimum of 5 minutes after shutoff occurs unless the generator is restarted. The standard also includes requirements for: (1) a label about the automatic shutoff that must be located near the notification indicator, and that instructs the consumer to move the generator to an outdoor area and seek medical help if feeling sick; (2) a marking on the generator to show the direction of the exhaust; (3) a self-monitoring system; (4) tamper resistance; and (5) the system's CO sensor. PGMA G300-2018 has an effective date of March 31, 2020, which means that if a manufacturer certified to PGMA G300 after that date, it must be certified to the 2018 edition, rather than the prior 2015 edition.

[46] The Clean Air Act requires EPA to establish national ambient air quality standards for certain common and widespread pollutants to address air pollution. Under the Clean Air Act, EPA sets emission standards for engines of all sizes, including those used in portable generators, to address air pollution. To show compliance with these emission standards, engine manufacturers must follow test procedures specified in 40 CFR part 1065.

[47] Edition Date: March 31, 2017; ANSI approved: October 7, 2022. UL 2034 is available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=32610

3. Assessing the Effectiveness of the CO Hazard Mitigation Requirements in the Voluntary Standards

Staff assessed the CO hazard-mitigation requirements of both these standards, and in February 2022, reported staff's findings regarding the effectiveness of these requirements (Effectiveness Analysis).[48] The effectiveness analysis involved staff working with NIST staff to simulate the scenarios for 511 actual fatalities in CPSC's databases using an indoor air quality (IAQ) modeling program called "CONTAM."[49] Staff's analysis found that under the simulated conditions, generators compliant with the shutoff requirements in PGMA G300 would avert nearly 87 percent of deaths that occurred with noncompliant (also referred to as baseline) generators, with 69 fatalities, 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released. Staff's analysis found that under the simulated conditions, generators compliant with the CO emission rate and CO shutoff requirements in UL 2201 would avert nearly 100 percent of the deaths, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. These results are shown in Table 2 below.[50] (see TAB A). The results of the effectiveness analysis show that the CO hazard-mitigation requirements of UL 2201 are more effective than those of PGMA G300-2018.[51]

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[48] *CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*, February 16, 2022 https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov)

[49] CONTAM (not an acronym) is a multizone airflow and contaminant transport IAQ modeling program that was developed by NIST and has been used for several decades. It models the buildup and transport of contaminants within, into, and out of a building. A range of validation studies have demonstrated its ability to predict reliably building air change rates and contaminant levels.

[50] Note: Table 2 contains revisions to the results reported in the briefing package referenced in footnote 48 due to a tabulation error that staff found in staff's analysis of the simulation results after publication. Staff's correction found that, for the survivors of the scenarios with a G300 generator, there would be one less survivor who would be hospitalized and 54 more survivors who would be treated and released compared to the injuries that were previously published. Staff also found that for the survivors of the scenarios with a UL 2201 generator, there would be two more survivors who would be treated and released compared to these injuries that were previously published.

[51] To provide a frame of reference for the CO concentrations required for shutoff, the CO concentrations that are required in UL 2034 (the U.S. voluntary standard for residential CO alarms) for alarm activation to alert occupants of dangerous CO concentrations are: the alarm shall activate for 70 ppmv CO between 60 to 240 min, 150 ppmv CO between10 min to 50 min, and 400 ppmv CO between 4 to 15 min. In each of these, the CO alarm must activate before the upper time limit is reached and must not activate before the lower time limit is reached. The upper time limit of these activation points is based on 10 percent COHb, which is the level at which one might begin to experience the onset of mild CO poisoning symptoms, such as a headache. For a correlation between COHb and exposure to a CO concentration for a given time duration, see Figure 41.1 in UL 2034, which is available for free digital viewing at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=32610. (It is important to note that the relationship between CO concentration and COHb is non-linear. This means that, for example, after a CO exposure profile has reached a peak and is decreasing, such as when a generator shuts off, the COHb will continue to rise for some time before COHb decreases. This is exemplified in test results presented in NIST Technical Note 2049 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Portable Generators with a CO Safety Shutoff Operating in a Test House*, available online at https://doi.org/10.6028/NIST.TN.2049. In the vast majority of the tests, the peak COHb levels were attained hours after the generator shut off.)

Table 2 Outcome of Effectiveness Analysis

Outcome for Operators and Collateral Occupants	Baseline vs. Standards		
	Baseline	G300	UL 2201
Fatality	511	69	0.04
Percentage of death averted versus baseline generators	- -	86.6%	99.99%
Survivors who are hospitalized or transferred to specialized treatment center	- -	54	3
Survivors who seek medical treatment and are treated and released	- -	88	24
Survivors who are likely not symptomatic and not seeking medical treatment	- -	300	484

Staff assesses that the requirements in PGMA G300 are not adequate to prevent the risk of injury or death associated with CO poisoning from portable generators because the shutoff requirement alone would leave 69 of the 511 fatalities unaddressed. Staff assesses that the CO emission rate and shutoff performance requirements from UL 2201 are extremely effective in simulations at reducing the risk injury or death associated with CO poisoning from portable generators. To ensure the adequacy and effectiveness of these performance requirements and ensure that the CO shutoff system functions properly in real-world scenarios, however, staff assesses that requirements missing from the UL standard, but based on requirements included in PGMA G300, are needed in the draft proposed rule. These additional requirements, with some modifications, relate to testing, tamper-resistance, self-monitoring system requirements, construction requirements to address the durability, reliability, and functionality of the CO shutoff system, and notification and labeling requirements.

E. Supplemental Notice of Proposed Rulemaking

Pursuant to Section 7 and 9 of the CPSA, this staff briefing package assesses UL 2201 and PGMA G300 to determine whether compliance with either standard is likely to result in the elimination or adequate reduction of the risk of acute CO poisoning associated with portable generators, as well as whether it is likely that there will be substantial compliance with either standard.

Based on the results in the analysis, staff assesses that the performance requirements of UL 2201 are extremely effective in reducing the risk of CO poisoning associated with portable generators and assesses that PGMA G300's requirements regarding testing, tamper resistance self-monitoring system requirements, construction requirements, and notification and labeling requirements for the CO safety shutoff system are necessary to ensure the effectiveness and adequacy of the UL 2201 emission rate and shutoff concentrations.

Staff assesses that it is not likely that there will be substantial compliance with either voluntary

standard. Even if the current version of UL 2201 voluntary standard (2nd Edition; 2018) included all the requirements discussed in the previous paragraph, the need for a mandatory standard remains as a result of a low level of manufacturers' compliance with the voluntary standards. See TAB B for additional discussion regarding compliance.

Thus, staff finds that neither standard adequately addresses the risk of deaths and injuries from CO poisoning from portable generators without the changes that staff proposes.

As a result, staff has developed an updated draft proposed rule that is based on requirements from UL 2201 and PGMA G300. Staff is not reproposing the 2016 NPR because staff concludes that the current draft proposed rule's requirements, developed with reference to voluntary standards work that has occurred since 2016, are more protective, and likely to reduce the risk of CO injuries and deaths to a greater degree than those in the 2016 NPR. The combination of requirements in this SNPR would likely address nearly all known fatalities associated with portable generators. Moreover, the SNPR has added requirements related to shutoff, which has been promoted by PGMA and has some degree of industry acceptance.

Accordingly, staff recommends the following performance requirements for portable generators in the draft proposed rule:

1. Limit the CO emissions to a maximum weighted rate of 150 g/h, as required in UL 2201, and verify conformance using either of the two test methods in UL 2201;
2. Shut off before exceeding a 10-minute rolling average of 150 ppmv CO, measured above the generator during compliance testing, as required in UL 2201;
3. Shut off before exceeding an instantaneous reading of 400 ppmv, measured above the generator during compliance testing, as required in UL 2201, with modification[52];
4. Verify conformance to the CO shutoff requirements using PGMA G300 test methods with modifications;[53] and
5. Include tamper resistance, self-monitoring system requirements, and construction requirements to address the durability, reliability, and functionality of the CO shutoff system, and notification and labeling requirements, with modifications, from PGMA G300.[54]

III. Discussion

A. Scope of the Draft Proposed Rule

The draft proposed rule applies to single-phase,[55] 300 volts (V) or lower, 60-hertz (Hz) generators that are provided with receptacle outlets for alternating current (AC) output circuits

[52] UL 2201 requires shutoff to occur *when* 400 ppmv is measured, not before exceeding 400ppmv.

[53] Modifications to the test method are described in TAB E.

[54] Modification to the requirements for tamper resistance are described in TAB E and modifications to the notification and labeling requirements are described in TAB F.

[55] Residential wiring systems typically consist of a single-phase power supply with two line conductors and a neutral conductor such that each line conductor is at a potential of 120 V to neutral, and the two lines are at a potential of 240

and intended to be moved by the consumer, although not necessarily with wheels. The engines in these portable generators are nonroad small spark ignition (SI) engines,[56] based on the EPA's engine classifications per 40 CFR § 1054.801, and are fueled by gasoline, LPG, or NG. In the 2016 NPR, the scope of the proposed rule divided generators into different categories, depending on the size of the generator's engine; and the proposed rule applied different emission rate limits, depending on the different-sized engines. The scope of this draft proposed rule does not divide the generators into different categories. Neither voluntary standard separates the generators into different categories, and requirements in the voluntary standards apply equally to all portable generators. Similarly, there is no longer a reason to separate portable generators into different categories based on staff's recommended requirements, and the requirements thus, would apply equally to all portable generators.

Staff has excluded the following generators from the scope of the draft proposed rule:

- *Permanent stationary generators*: excluded because they have installations and use patterns that differ from portable generators. They are installed in a fixed location outside the home with permanent electrical and fuel (NG or LPG) connections that minimize consumer interaction with the product. In addition, they are covered by different safety standards.[57]
- *50-Hz generators*: excluded because 50-Hz power systems are not used in the United States.
- *Marine generators and generators permanently mounted in recreational vehicles or motor homes*: excluded because, even though these models may be similar to those falling within the scope of this draft proposed rule, they generally are outside CPSC's jurisdiction under the CPSA.
- *Generators solely intended to be pulled by, or mounted on, vehicles*: excluded because these generators are primarily work-related and are not typically consumer products.
- *Generators with compression ignition (CI) (i.e., diesel) engines*: excluded because CPSC staff is not able to confirm any fatality as involving a diesel generator. Diesel engines emit significantly less CO than SI engines. Furthermore, portable diesel generators are primarily used by individuals in a work-related setting or environment, and typically are not within CPSC's jurisdiction.
- *Industrial-type generators intended solely for connection to a temporary circuit breaker panel at a jobsite, and not for consumer use*. Staff is not aware of any consumer CO incidents involving these generators.

V. The draft rule excludes three-phase generators, which are rarely used in residences, but are widely used in commercial and industrial applications where power demands are higher; a three-phase generator output includes three line conductors.

[56] These are engines used for lawn and garden equipment and other small outdoor power equipment and tools. Spark-ignition means that a spark ignites the air-fuel mixture in the engine's cylinder to initiate the combustion process. The combustion process converts the latent energy of the fuel into mechanical power when the explosion of the fuel-air mixture pushes the piston down in the cylinder, which, in turn, rotates the engine's crankshaft.

[57] The applicable product safety standard for stationary generators is ANSI/CAN/UL/ULC 2200 - *Stationary Engine Generator Assemblies*. Consumers generally do not self-install residential stationary generators. Installers would need to comply with the manufacturer's instructions and the applicable codes (likely NFPA 70 – *National Electrical Code* (*NEC*), and NFPA 37 - *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*) being enforced by the local authority having jurisdiction in accordance with local or state ordinances.

B. The Draft Proposed Rule's Requirements

The draft proposed rule requires in-scope portable generators to emit no more than a weighted CO rate of 150 g/h of CO and to automatically shut down when a specific CO concentration is detected at a specified height above the generator. Additional requirements address tests to verify compliance to those requirements, as well as the durability, reliability, and functionality of the shutoff system. Table 3 summarizes the requirements included in the draft proposed rule. It also compares those requirements with the requirements included in the voluntary standards. The following sections describe the draft proposed rule's requirements and their rationale. Tab H contains a summary description of the requirements.

1. CO Emission Rate and CO Shutoff Requirements

The draft proposed rule would incorporate UL 2201's CO emission rate requirement of a maximum of 150 g/h and UL 2201's shutoff concentrations of a maximum of 400 ppmv instantaneous or 150 ppmv for a 10-minute rolling average, measured above the generator during compliance testing. Staff's analysis of the results from the simulations performed by NIST that replicated the scenarios of 511 deaths in CPSC databases, described in section II.D. and in TAB E, shows that these CO emission rate and shutoff requirements would have prevented nearly all (99.99%) of the deaths and the survivors would have sustained relatively few injuries. The CO hazard mitigation requirements in PGMA G300, which do not include a CO emission rate limit and requires shutoff before exceeding 800 ppmv or a 10-minute rolling average of 400 ppmv,left 69 deaths in the simulations unaddressed and also resulted in more survivors with injuries requiring hospitalization or non-admitted treatment. Thus, these shutoff concentrations from PGMA G300 are not used in the draft proposed rule.

Therefore, based on these simulations, staff concludes that the limits established by these emission and shutoff concentrations from UL 2201 are effective in addressing the risk of CO poisoning injury and death from portable generators. However, as explained herein, staff assesses that additional requirements are necessary to ensure the performance requirements as assessed in the effectiveness analysis adequately and effectively address the risk of injury and death in real-world scenarios.

2. Test Method for Verifying Compliance with CO Emission Rate

PGMA G300 does not have a CO emission rate requirement; therefore, it does not have a test method for verifying compliance to a CO emission rate. Section 5 of UL 2201 has two options for test methods to verify compliance to the CO emission rate. The draft proposed rule incorporates both of these test methods. The first option measures the CO emission rate of the fully assembled portable generator as received by the consumer. The second option measures the CO emission rate of just the engine mounted on a dynamometer. (A dynamometer is a device for applying a precise load on the engine. This simulates the load on the engine from appliances and tools consumers would plug into the generator for power.)

In the first option for the test methods, the loads to be applied to the generator are based on the maximum available observed wattage, which is the same as rated wattage as determined in Section 6.3.2 of PGMA G300.

3. Test Method for Verifying Compliance with CO Shutoff Requirement

The draft proposed rule includes requirements for a standardized test method to verify compliance with the CO shutoff criteria. The simulation analysis demonstrated that the CO emission rate and shutoff concentrations in UL 2201 can be extremely effective in addressing the fatalities and injuries associated with CO poisoning; but to ensure the adequacy and effectiveness of these performance requirements in practice, staff assesses that an effective test method for verifying compliance with the CO shutoff requirement is necessary. An effective test method must expose the CO safety shutoff system to a rising concentration of CO in an enclosed room that will exceed the concentrations of the acceptance criteria to evaluate if the generator will shut off within the required limits. Analyzing the test methods in both UL 2201 and PGMA G300, staff determined that the test method in PGMA G300 provides a reasonable foundation for a test method. The test consists of running the generator in an enclosed room (chamber) while measuring the rising concentration of CO within the room. The test requires that the generator shut off within the acceptance criteria. Staff also recommends some modifications to the PGMA test method, such as room size and ventilation, to improve consistency, reliability, and operator safety of the tests. See TAB E for more details.

4. Maintaining Functionality of the CO Shutoff System

The simulations assessing the effectiveness of the performance requirements in the voluntary standards assumed the shutoff system functioned properly and shut the generator off when the shutoff criteria in each voluntary standard were met. If the shutoff system is bypassed, damaged, or overridden, such that the generator can operate without the shutoff system functioning properly, the effectiveness of the performance requirements in UL 2201 would be reduced. Thus, staff assesses that requirements to maintain the functionality of the shutoff system are necessary in the draft proposed rule.

PGMA G300 has requirements regarding tamper resistance in sections 3.9.1.2.1. through 3.9.1.2.4. Specifically, section 3.9.1.2.1 requires that the portable generator shutoff system be tamper resistant and specifies when a system is considered tamper resistant. According to Section 3.9.1.2.1, the shutoff system is considered tamper resistant when all parts that affect the proper operation of the shutoff system meet at least one of the following: (1) the part is permanently sealed; (2) the part is not normally accessible by hand or with ordinary tools; or (3) removal or disconnection of the part prevents the engine from running. Section 3.9.1.2.1 allows for different parts of the shutoff system to meet the requirement for tamper resistance using any of the three options, provided all of the different parts meet at least one of the options. Staff concludes that the requirements in section 3.9.1.2.1 are inadequate because item (3) is not mandatory and there is not a requirement that precludes the generator from being able to operate or continue to operate when the CO sensor is bypassed in the circuitry. Accordingly, the draft proposed rule includes that removal or disconnection of the part prevents the engine from running is mandatory, rather than being an optional means to achieve tamper resistance. Furthermore, the draft proposed rule includes an additional requirement that states shorting any part that disables the operation of the system shall prevent the engine from running.

Section 3.9.1.2.2 of PGMA G300 requires that construction of the portable generator minimize the risk of intentional blockage of the gas inlet of the shutoff system. Section 3.9.1.2.3 provides that the construction of the portable generator shall minimize the risk of incidental damage to

the shutoff system. Section 3.9.1.2.4 provides that the shutoff system shall not incorporate any type of override function or feature. Staff concludes that these requirements are necessary and adequate to ensure the CO shutoff system maintains functionality.

UL 2201 does not have any requirements that address these issues, which makes the standard inadequate to ensure the effectiveness of its CO hazard mitigation requirements.

5. Self-Monitoring of the CO Shutoff System

The effectiveness analysis assumed the shutoff system functioned properly and shut the generator off before exceeding the shutoff criteria in each voluntary standard. If the system has a fault, loss of power, or the system reaches end of life, yet the generator operates without the shutoff system functioning, the effectiveness of the performance requirements would be reduced. Therefore, staff assesses that requirements for self-monitoring of the shutoff system are necessary. PGMA G300 provides requirements for self-monitoring, while UL 2201 does not. PGMA G300's requirements in section 3.9.1.1 require that faults, indicative of a fault with the CO sensing element, loss of power source for the CO shutoff system, and end-of-life condition, be applied one at a time to the system's circuitry while the engine is running, The engine is required to shut off after each fault or end of life signal is introduced. Staff concludes that these self-monitoring requirements are necessary for ensuring proper functioning of the shutoff system. Thus, the requirements are included in the draft proposed rule.

6. Durability Requirements of the CO Shutoff System

Staff's effectiveness analysis of the voluntary standards assumes the shutoff system is durable and reliable and always shuts off the generator before exceeding the prescribed CO concentration requirements for each voluntary standard. Durable and reliable operation of the CO shutoff system is critical. Section 3.9.1 of PGMA G300 specifies durability requirements for the shutoff system by referencing applicable sections of UL 2034, *Single and Multiple Station Carbon Monoxide Alarms.* Section 3.9.1 of PGMA G300 requires the system must be designed to withstand gas and vapor interference, vibration, dust, corrosion, varying temperature and humidity, which are environmental conditions associated with the use, transportation, and storage of portable generators. Staff concludes that the CO shutoff system must meet PGMA G300 section 3.9.1 (referencing appropriate sections of UL 2034) with modifications necessary to meet the requirements in the draft proposed rule, such as the concentration limits for CO shutoff. UL 2034 should be used as the minimum requirement for the design and performance of the CO shutoff system. Without this durability requirement, the CO sensor might fail frequently, which could increase the likelihood of the user attempting to tamper with the system so that they can operate the generator in spite of the failed CO sensor. Additionally, section 3.9.1.4 of PGMA G300 requires that the CO sensor used in the shutoff system have a UL mark or equivalent Nationally Recognized Testing Laboratory (NRTL) mark. This ensures that the sensor is capable of meeting the requirements for use in UL 2034-compliant systems.

Staff concludes that UL 2201, on its own, is not adequate to address the CO shutoff system because it does not prescribe requirements for the construction of the CO shutoff system. If the system does not function properly because of conditions affecting its durability and ability to reliably shut the generator off when the shutoff criteria are met, the effectiveness will be reduced. Staff recommends incorporating into the draft proposed rule, construction and

performance requirements in section 3.9.1 and 3.9.1.4 of PGMA G300, with the modification to CO concentration shutoff criteria. These requirements address the environmental conditions (gas and vapor interference, dust, vibration, corrosion, and variable temperature and humidity) that the shutoff system could be exposed to when mounted on a portable generator.

Staff recommends that the Commission seek comments on the durability requirement of the CO shutoff system.

7. Notification System and Labeling for the CO Shutoff System

Staff concludes that CO shutoff notification and labeling requirements are necessary to adequately reduce the risk of CO poisoning. Staff considers the notification requirements in PGMA G300 to be a reasonable foundation for requirements in the draft proposed rule. However, as discussed in detail in TAB F, staff assesses the "indication" requirements specified in PGMA G300 to be insufficient. Staff concludes that the following revisions to the indication requirements of PGMA G300 would further reduce the risk of injury or death associated with portable generators:

- Require that the "red indication" be illuminated.
- Require the indication to meet the visibility and conspicuousness requirements relative to a consumer who is positioned in front of the startup controls.
- Require the red indication to be at least 0.4 inches (10 mm) diameter in size.
- Specify that the indication, if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark durations.

Staff seeks public comments on the following additional indication-related issues, which are discussed in TAB F:

- Is a minimum luminance requirement needed for the indication, and if so, what would be an appropriate requirement?
- Is PGMA G300's minimum indication duration of 5 minutes after shutoff occurs, unless the generator is restarted, sufficient?

As discussed in TAB F, staff also concludes that the PGMA G300 requirements specific to the notification label are insufficient and that certain revisions are reasonably necessary to adequately reduce the risk of injury or death. Staff recommends the following changes to this label:

- Require the label to be located no more than 0.25 inches (6.35 mm) from the notification indicator, or for the indicator to be incorporated into the label.
- Change the language of the header to state explicitly why the generator shut off.
- Reformat the text in the message panels to use sentence capitalization rather than all-uppercase text, except when highlighting key phrases.

- Revise the language to clarify that the generator must be moved before restarting the generator, and to reduce redundancy with the content of the mandatory DANGER label.[58,59]
- Add sizing requirements for the label in terms of the minimum allowable type size for the contents.

See TAB F for more details.

[58] 16 CFR part 1407, *Portable Generators; Final Rule; Labeling Requirements*, *Federal Register*, 72 FR 1443, January 12, 2007.

[59] 16 CFR Part 1407, *Portable Generators; Final Rule; Labeling Requirements*, *Federal Register*, 72 FR 2184, January 18, 2007.

Table 3 – Requirements of the Draft Proposed Rule versus Voluntary Standards

Requirement	PGMA G300	UL 2201	Draft Proposed Rule
Limit weighted CO emissions rate of portable generator to a maximum of 150 g/h, including test methods for verifying compliance		✓	✓
Two test methods for verifying compliance: assembly & engine			Same as UL 2201
Require the generator to shut off before the concentration measured above the generator exceeds a threshold for either an instantaneous reading or a concentration over a 10-minute rolling average	✓	✓	✓
Reading limits: instantaneous & rolling average	800 ppmv instantaneous & 400 ppmv over 10 minute average	400 ppmv instantaneous & 150 ppmv over 10 minute average	Same concentrations as UL 2201
Test Method for Verifying Compliance with CO shutoff requirement	✓	✓	✓
Type of test:	One test with specified temperature, ventilation, room dimensions/volume, and load	Three tests with different temperatures, ventilation, and load. Room dimensions/volume are also specified	One test with specified ventilation rate (inlet/outlet position, a fan), generator's position within the room (potentially larger), and load & power meter specifications.
Sensor/Shutoff System - Maintaining functionality	✓		✓
- Tamper resistance: shorting, disconnecting, or removing any part that disables the operation of the system shall prevent the engine from running *- Construction requirements: shall minimize ability to intentionally block gas inlet to CO sensor and risk of incidental damage to the system* *- No override function or feature.*			Same as PGMA G300, except for modified tamper resistance requirement
Sensor/Shutoff System - Self-monitoring	✓		✓

Requirement	PGMA G300	UL 2201	Draft Proposed Rule
Engine shuts off if there is an indication of a fault with the CO sensing system, loss of power, or end of the sensor's life			Same as PGMA G300
Sensor/Shutoff System - Durability & Reliability	✓		✓
Sensor/shutoff system performing under multiple environment conditions (gas/vapor interference, dust, vibration, corrosion, temperature, and humidity) is able to reliably shut the generator off when threshold concentrations are reached			Same as PGMA G300
Notification, Markings, and Labeling	✓		✓
System notifies consumers the reason for the shutoff, the actions that should follow, and the risk of continued operation	1) red indication (size, location brightness, function); and 2) product markings (risk of tampering, close proximity, direction of exhaust)		1) red indication (illuminated & blinking, conspicuous location, duration, and size); and 2) product markings (specific location, hazard description, clear language and directions, format)

C. Preliminary Regulatory Analysis

CPSC staff from the Directorate for Economic Analysis (EC) prepared a Preliminary Regulatory Analysis (TAB B) and an Initial Regulatory Flexibility Analysis (TAB C). This section summarizes the information in the Preliminary Regulatory Analysis included in this NPR.

1. Cost Analysis

The draft proposed rule would impose the following costs: increased variable costs of producing portable generators with reduced CO-emission rates and CO sensors with shutoff capabilities; one-time conversion costs of redesigning existing portable generator models and modifying manufacturing operations for the development of portable generators with reduced emissions and with CO sensors/shut-off systems; recurrent testing cost to validate compliance of each new model with the proposed standard; sensor replacement costs to consumers for the substitution of failed CO sensors or CO sensors that have reached end of life; and deadweight loss[64] caused by price increases resulting from increased manufacturing costs. Staff performed a 30-year prospective cost assessment (2024-2053) of these four cost categories and estimated the total annualized incremental cost from the draft proposed rule to be $148.94 million, discounted at 3 percent.[65] Staff estimated the present value of costs per portable generator upgraded to the standards of the draft proposed rule to be $38.85, discounted at 3 percent. This is modest in comparison to the current retail cost of portable generators subject to the rule, which is approximately $1,000, on average.

2. Benefits Analysis

Staff also conducted a benefits analysis of the draft proposed rule. The benefits analysis accounted for the prevention of deaths and injuries from introducing compliant portable generators, which staff monetized using the value of statistical life (VSL) for deaths and estimates of the cost per type of injury from the ICM. Over the 30-year study period, staff estimated the draft proposed rule would prevent 2,148 deaths (nearly 72 deaths per year) and 126,387 injuries (roughly 4,213 injuries per year). The total annualized benefits from the draft proposed rule are $1,046 million, discounted at 3 percent. Staff estimated the per-unit benefits from the draft proposed rule to be $272.84, discounted at 3 percent.

3. Comparison of Potential Costs and Benefits of the Draft Proposed Rule for Portable Generators

The benefits of the draft proposed rule far exceed the estimated costs. Staff calculates net benefits (benefits less costs) to be $897.06 million on an annualized basis, discounted at 3 percent. The table below displays benefits, costs, net benefits, and the benefit-cost ratios from an annualized perspective among the assumptions of no discounting, a 3 percent discount rate, and a 7 percent discount rate.

[64] Deadweight loss is the net loss to consumers and producers of the value generated from lost transactions that would have occurred in the absence of the new regulation.

[65] Staff uses a discount rate to incorporate the time value of money during the 30-year study period. In the analysis, staff presents both costs and benefits in undiscounted dollars, discounted at 3 percent, and discounted at 7 percent.

Table 4. Annualized Net Benefits and B/C

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$1,202.09	$1,046.00	$859.13
Costs	$154.43	$148.94	$143.56
Net Benefits (Benefits – Costs)	$1,047.65	$897.06	$715.57
B/C Ratio	7.78	7.02	5.98

The net benefits on per-unit basis, when discounted at 3 percent, are $233.99. These net benefits per product represent roughly 23 percent of the average price of a portable generator, whereas costs are only about 4 percent of the average price. The table below displays benefits, costs, net benefits, and the benefit-cost ratios from a per-unit perspective among the assumptions of no discounting, a 3 percent discount rate, and a 7 percent discount rate.

Table 5. Per-Unit Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Per Unit Net Benefits ($)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$479.92	$272.84	$141.88
Costs	$61.66	$38.85	$23.71
Net Benefits (Benefits – Costs)	$418.26	$233.99	$118.17
B/C Ratio	7.78	7.02	5.98

Overall, the draft proposed rule has a benefit-cost ratio of 7.02 under a 3 percent discount rate and from both an annualized and per-unit perspective. In other words, for every $1 in direct cost to consumers and manufacturers, the draft proposed rule generates $7.02 in benefits from mitigated deaths and injuries.

D. Initial Regulatory Flexibility Analysis

When an agency publishes a proposed rule, Section 603 of the Regulatory Flexibility Act (RFA), 5 USC 601 – 612, generally requires the agency to prepare an initial regulatory flexibility analysis (IRFA) describing the impact of the draft proposed rule on small businesses and other entities. This section summarizes the main findings of the IRFA. The full IRFA can be found in Tab C.

Staff has identified four small manufacturers of portable generators and 20 small importers of portable generators that would be impacted by the draft proposed rule. As presented in the previous section, CPSC staff estimates that, on average, the requirements will increase the per-unit costs to generator manufacturers by roughly $53.38 (cost of manufacturing and redesign/testing without discounting). The costs might be higher for lower-volume

manufacturers.

Staff identified four manufacturers that meet the U.S. Small Business Administration (SBA) criteria to be considered small firms. For three of these firms, the apparent mix of products that they produce are mostly outside the portable generator category. One producer is primarily engaged in the production of portable generators and likely to be impacted financially by the proposed new rule.

In summary, the draft proposed rule is unlikely to have a significant adverse economic impact on three of the four identified small manufacturers and unlikely to have a significant direct impact on the small portable generator importers.

Generator manufacturers and importers will be responsible for certifying that their products comply with the requirements of the draft proposed rule. Testing and certification costs can have a disproportionate impact on small manufacturers, depending upon the cost of the tests and volume of production relative to larger manufacturers.

CPSC staff recommends that the Commission seek comment on, in particular:

- whether any manufacturing costs that might disproportionately impact small businesses were not considered in this analysis,
- the costs of the testing and certification requirements of the draft proposed rule, and
- differential impacts of the draft proposed rule on small manufacturers or suppliers that compete in different segments of the portable generator market.

See TAB C for more details.

E. Certification to the Draft Proposed Rule

The CPSA requires that manufacturers (the term includes importers) certify that their products comply with applicable CPSC standards and regulations. 15 U.S.C. § 2063(a)(1). If the Commission should finalize a portable generator rule, manufacturers, including importers, would need to certify that the product conforms to the standard. For products that manufacturers certify, manufacturers would issue a general certificate of conformity (GCC). The requirements for the GCC are stated in Section 14 of the CPSA.

F. Effective Date of the Draft Proposed Rule

Under the CPSA, the effective date for a consumer product safety standard must be at least 30 days after promulgation of a final rule and must not exceed 180 days from the date the final rule is promulgated, unless the Commission finds for good cause that an earlier or later effective date is in the public interest.

For this draft proposed rule, staff recommends an effective date of 180 days after publication of the final rule in the *Federal Register*. The 2016 NPR proposed an effective date 1 year after publication of the final rule for larger generators and 3 years for smaller generators, to allow enough time to comply, due to possible significant modifications associated with the use of

closed-loop fuel injection and fuel control closer to stoichiometry,[66] such as adding cooling fins and a fan, which staff considered at the time likely would be needed to meet the proposed CO emission rates in the NPR. However, significant changes have occurred since the NPR that led to staff reassessing that a 1-year effective date for larger generators, and 3-year effective date for smaller generators, is no longer necessary.

Since the NPR, industry has published voluntary standards and some manufacturers have adopted them, which demonstrated their feasibility. In 2018, UL published UL 2201, which has a requirement of a maximum weighted CO emission rate of 150 g/h for all portable generators.[67] At least one portable generator manufacturer currently certifies products to both UL 2201 and PGMA G300. Two other manufacturers each have one model in the marketplace that are certified to PGMA G300; and although not certified to UL 2201, staff expects these models would meet the draft proposed rule's CO emission rate requirement. One is a popular model of a brand-name gasoline generator that has been converted to run on propane, and the other is a recently introduced gasoline generator.

Notwithstanding these models currently on the market, staff assesses that most manufacturers will likely need time to develop, test, and plan for production of portable generators that would meet the draft proposed requirements, particularly the CO emission rate requirement. While the technology that the draft proposed rule would require is based on existing technology and the requirements are based on those in the existing voluntary standards, there are complicated engineering and multiprocess operational issues involved in altering portable generators to be compliant. Therefore, staff recommends 180 days, and recommends that the Commission seek public comment on this time frame.

G. Stockpiling

The draft proposed rule includes an anti-stockpiling provision[68] that would prohibit a manufacturer from "stockpiling" or substantially increasing the manufacture or importation of noncompliant portable generators between the promulgation of the final rule and the effective date. The provision would prohibit the manufacture or importation of noncompliant products at a rate that is greater than 120 percent at which the firm manufactured and/or imported portable generators during the base period. The base period is the average monthly manufacture or import volume for any continuous 180-day period within the last 12 months immediately preceding the month of promulgation of the final rule.

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[66] Stoichiometry refers to the exact ratios of oxygen and fuel chemicals called for by the chemical reactions to fully burn the fuels with no shortage or excess of oxygen.

[67] *UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition,* Dated January 9, 2018.

[68] According to Section 9 paragraph (g)(2) of the CPSA, CPSC is required to consider whether to prohibit stockpiling from the date of promulgation of the rule to the effective date of the rule. "Stockpiling" is defined as manufacturing or importing noncompliant products that is significantly greater than the rate at which such products were produced or imported during a base period. The base period is defined as the 12 months preceding promulgation of the rule.

Portable generator sales have historically been volatile throughout the years[69] and can be significantly affected by extreme weather events.[70,71] Staff was unable to find observed data of recent sales. Therefore, staff recommends a base period of 12 months, using the general forecasting assumption that the most appropriate predictor of sales–in lieu of specific data–is the previous year's sales. Staff requests that the Commission seek public comment on recent data of portable generator sales to help inform this assessment. Staff sets the rate of the manufacturing or importing to 120 percent of the base period to allow for flexibility in a volatile market and account for extreme weather events. A 120 percent rate has been the upper limit for other CPSC rules.

H. Regulatory Alternatives

Staff has identified alternatives (see TAB B) to staff's draft proposed rule that the Commission might consider to address the risks of deaths and injuries caused by CO poisoning from consumer use of portable generators. The following describes these alternatives.

1. Implement the Draft Proposed Rule with the Exception of the CO-Emission Requirements and CO Concentrations for Shutoff Included in Voluntary Standard UL 2201

Alternative 1 to the draft proposed rule is to require portable generator manufacturers to comply with the PGMA G300-2018 voluntary standard with modifications required to ensure durability, reliability, and safe operation of the sensor/shutoff system. Staff considered this alternative because it provides some reduction of the risk of CO poisoning from portable generators operating in enclosed spaces, and also because implementation costs are likely lower, while current compliance with the sensor/shutoff requirement is higher (compared to compliance with the emission requirement). Staff rejected this alternative because it would result in 372 fewer deaths averted and 11,135 more injuries over 30 years compared to the draft proposed rule, and the net benefits of the draft proposed rule are higher than the benefits of this alternative.

It is important to emphasize that the G300-compliant generator efficacy rates in reducing injuries may be overstated because the simulation analysis does not fully account for injuries produced during outdoor use of G300-complaint generators. Because the PGMA G300 standard does not restrict emissions, G300-compliant generators that do not shut off as designed present the same risk of CO poisoning as a noncompliant generator. Therefore, the benefits used in the above analyses may exceed the real-life benefits of implementation of Alternative 1.

[69] The average yearly growth from observed sales (1996-2014) is 12.60% with a standard deviation of 40.58%.

[70] Willis, Kara, "Fear of power outages lead to generator shortage," June 16, 2021, *12News*, https://www.12newsnow.com/article/weather/fear-of-power-outage-due-summer-heat-and-gulf-disturbance-leads-to-generator-shortage/502-58aeb7a3-fd9e-4928-91fb-41dd4afb5a16

[71] Garcia-Buckalew, "Icy weather on the way and no portable electric generators to be found," February 1, 2022, *KVUE-ABC*, https://www.kvue.com/article/news/local/texas/portable-electric-generator-shortage/269-4b48209a-e692-4d67-b745-8744960f539b

2. Await Possible Adoption of the Draft Proposed Rule Requirements into UL 2201 or PGMA G300

Alternative 2 proposes reliance on voluntary standard stakeholders[72] to adopt all the requirements included in the draft proposed rule, into either voluntary standard, UL 2201, or PGMA G300. Staff does not recommend this alternative for two main reasons: (1) the likelihood of obtaining consensus on a voluntary standard that has all the requirements of the draft proposed rule is very low, and (2) currently, there is low compliance with either voluntary standard. Therefore, staff concludes that it is reasonable to assume that even if a voluntary standard with all of the draft proposed rule's requirements were to achieve consensus, it would not be substantially complied with by manufacturers.

3. Issue a Rule that Relies on Either UL 2201 2nd Edition, or PGMA G300-2018 as They Are Currently Written

This alternative to the draft proposed rule is a rule that requires portable generators to comply with either the UL 2201 (2nd Edition; 2018) or PMGA G300-2018. Staff does not recommend this alternative because, as stated earlier, neither standard is adequate. Staff assesses that the shutoff requirements in PGMA G300 would leave 69 of the 511 fatalities unaddressed, and other requirements are not adequate, such as those for tamper resistance, requirements for verifying compliance with the shutoff requirements, and notification and labeling requirements. Staff assesses that the CO emission rate and shutoff performance requirements from UL 2201 are extremely effective in reducing the risk of injury or death associated with CO poisoning from portable generators. However, this standard lacks the requirements necessary to ensure the durability, reliability, and functionality of the CO shutoff system and notification and labeling requirements.

4. Not Issue a Rule, and Continue to Conduct Information and Education Campaigns

Staff considered the merits of not issuing the draft proposed rule, and instead, relying on continued education and information campaigns. Existing CPSC education and information campaigns on the hazards associated with CO and CPSC advocacy on smoke and CO alarm adoption could increase the presence of CO alarms in homes. Although CPSC staff supports and acknowledges the importance of such efforts, staff does not believe that these efforts are the most effective way to reduce CO poisonings, or that these efforts should take the place of performance requirements that would directly address the CO poisoning hazard associated with portable generators. This is reinforced by staff's finding that the annual number of generator-related CO deaths have not declined in recent years, and actually appear to be increasing.

[72] For instance, stakeholders on the STP for UL 2201 or a canvass committee for PGMA G300.

CPSC recommends that every home should have one or more CO alarms.[73] Per staff's case study of CO exposures in homes from generators operating outside after Hurricane Ida (see TAB D), CO alarms helped prevent injuries and likely saved lives in the incidents with homes that had working CO alarms and likely could have also helped in the incidents where homes did not have working CO alarms. CO alarms are effective, and can be lifesaving devices, but they should be considered the *last* line of defense. The accepted hierarchy for reducing the risk from a hazard is to reduce it at its source and if that is not possible, then guard against the hazard. The draft proposed rule reduces the hazard at the source.

5. Take No Action

Finally, CPSC considered the merits of taking no action. An assessment of the trends in deaths and injuries and the low adoption of the voluntary standards indicate this problem will not correct itself. Indeed, incidents with both injuries and deaths will likely increase as more noncomplying portable generators enter the market and are put in use. Meanwhile, society will still bear the burden of preventable fatalities and injuries from CO-related deaths and injuries associated with portable generators. Over the next 30 years, at current levels of compliance with the voluntary standards, deaths are expected to exceed 2,600, with roughly 154,000 injuries, and a total societal cost in excess of $27 billion (discounted at 3 percent).

IV. Conclusions and Recommendation

CO poisoning from portable generators has caused at least 1,332 fatalities (entered in CPSC databases as of May 10, 2022) and an estimated 77,658 medically attended injuries in the 18-year period from 2004 through 2021. There are two voluntary standards that have requirements intended to address the risk of acute CO poisoning associated with portable generators: UL 2201 and PGMA G300. The Effectiveness Analysis demonstrated that under simulated conditions, the performance requirements in UL 2201 would have averted nearly 100 percent of the fatalities, and UL PGMA G300 would have averted nearly 87 percent of the fatalities. Staff recommends that the draft proposed rule include the CO emission rate and CO shutoff requirements from UL 2201. Staff recommends that the draft proposed rule also include the CO shutoff system requirements from PGMA G300 and the notification and labeling regarding the shutoff system from PGMA G300, with some modifications, to ensure the durability, reliability, and functionality of the CO sensor and shutoff performance requirements. The draft proposed rule includes an effective date of 180 days after the date of publication of the final rule in the *Federal Register*. Staff recommends that the Commission approve the draft proposed rule to address the risk of acute CO poisoning associated with portable generators.

[73] More specifically, CPSC recommends every home have battery-operated CO alarms or CO alarms with battery backup on each level and outside separate sleeping areas. Furthermore, CPSC recommends that the CO alarms be interconnected so that when one activates, they all activate.

TAB A: Analysis of Effectiveness Provided by the Draft Proposed Rule and a Regulatory Alternative in Terms of Deaths and Injuries Treated in Hospital Emergency Departments

United States
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Memorandum

TO: Janet L. Buyer, Project Manager, Portable Generators Project
Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

DATE: January 28, 2023

FROM: Stephen Hanway, M.S. Associate Executive Director
Directorate for Epidemiology

SUBJECT: Analysis of Effectiveness Provided by the Draft Proposed Rule and a Regulatory Alternative in Terms of Deaths and Injuries Treated in Hospital Emergency Departments

I. Purpose

The purpose of this memorandum is to provide the following:

- Results of staff's effectiveness analysis of the carbon monoxide (CO) hazard-mitigation requirements in two voluntary standards, *ANSI/PGMA G300-2018, Safety and Performance of Portable Generators* and *UL 2201, Second Edition, Standard for Carbon Monoxide (CO) Emission Rate of Portable Generator*, referred to as PGMA G300 and UL 2201, respectively, based on simulations that were performed to replicate the scenarios of 511 generator-related CO fatalities in CPSC's databases.
- National estimates of generator-related CO injuries that were treated in hospital emergency departments (ED) that occurred in the years 2004 through 2021.
- Consumer CO deaths associated with generators in CPSC's databases as of May 10, 2022, that occurred in the years 2004 through 2021.
- Using the above information, estimates of what the CO injuries seen in EDs for the years 2004 through 2021 would have been if the generators involved in those injuries had complied with either voluntary standard, but the scenarios were otherwise similar.
- Staff's assessment of how a longer run time might affect the estimated injuries caused by generators complying with UL 2201.
- A count of fatal incidents in CPSC's databases, as of May 10, 2022, that occurred with the generator operating outside, in the years 2004 through 2021.

II. Discussion

A. *Effectiveness Analysis of the CO Hazard-Mitigation Requirements in PGMA G300-2018 and UL 2201, Based on Simulations Replicating the Scenarios of 511 Fatalities in CPSC's Databases*

To evaluate the effectiveness of the shut-off requirements of PGMA G300 and the emission rate and shut-off requirements of UL 2201, CPSC staff worked with staff of the National Institute for Standards and Technology (NIST) to simulate the scenarios of 511 CO fatalities in CPSC's databases that were caused by generators that did not comply with this standard in this draft proposed rule (also referred to as "baseline generators"), using an indoor air quality (IAQ) modeling program. The 511 simulated CO fatalities are based on the actual fatalities found in CPSC records over the 9-year period from 2004 through 2012, that occurred at fixed residential structures or similar structures. Staff then analyzed the simulation results to determine how many of the 511 deaths would have resulted in a death or one of two levels of CO injury severity[1] if the involved generator met one of the voluntary standards.[2] The results of that analysis are shown in Table 1. Some of the results differ from those previously published in staff's briefing package on effectiveness of the voluntary standards (see footnote 2) because staff found a tabulation error in the analysis of the simulation results after publication.[3]

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[1] The four criteria staff used to interpret predicted fatal COHb profiles are:

1. If peak level is ≥60% COHb, assume death.
2. If peak level is ≥50% COHb, but <60%, assume death, unless average duration with > 50 % COHb is less than 2 hours, and average duration between ≥40% and <50% COHb is less than 4 hours. In that case, assume survival.
3. If peak level is ≥40% COHb, but <50% COHb, assume death if duration of the average in this range exceeds 6 hours. Otherwise, assume survival.
4. If peak level is ≤40% COHb, assume survival.

In addition to the simulated fatalities analysis, CPSC HS staff developed criteria for estimating potential severity of injuries for the survivors of what formerly would have been fatal exposures. The injury level determinations also employ the calculated COHb levels, as in CPSC staff's fatality assessment, as follows:

1. <15% COHb – assume minimal if any perceptible symptoms in healthy adults – unlikely to seek medical treatment
2. ≥15% COHb but <25% COHb – assume likely to perceive adverse symptoms and to seek medical evaluation in emergency room (ER) or other medical setting, but likely to be released without need for hospitalization or for a transfer to a hyperbaric oxygen (HBO) treatment facility or other specialized treatment center
3. ≥25% COHb but <40% COHb for no more than 6 hours – assume likely to perceive adverse symptoms and to seek or be taken for medical evaluation in ER or other medical setting, and likely to be hospitalized or transferred to an HBO-treatment facility or other specialized treatment center

[2] *CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators,* February 16, 2022 https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov)

[3] Staff's correction found that, for the survivors of the scenarios with a G300 generator, there would be one less survivor who would be hospitalized and 54 more survivors who would be treated and released compared to the injuries that were previously published in the staff briefing package referenced in the above footnote. Staff also found that for the survivors of the scenarios with a UL 2201 generator, there would be two more survivors who would be treated and released compared to these injuries that were previously published.

Table 1. Results of effectiveness analysis of voluntary standards, based on simulations of 511 CO deaths in CPSC databases from generators, 2004-2012

Outcome for Operators and Collateral Occupants	Baseline vs. Standards		
	Baseline	G300	UL 2201
Fatality	511	68.50	0.04
Percentage of death averted versus baseline generators	- -	86.6%	99.99%
Survivors who are hospitalized or transferred to specialized treatment center	- -	54.22	3.22
Survivors who seek medical treatment and are treated and released	- -	87.96	24.28
Survivors who are likely not symptomatic and not seeking medical treatment	- -	300.42	483.56

B. National Estimates of Generator-Related CO Injuries Seen in Hospital Emergency Departments, 2004 Through 2021

Based on the CPSC's National Electronic Injury Surveillance System (NEISS) database, which is a national probability sample of approximately 100 hospitals in the United States and its territories, staff estimates that there were 23,318 CO injuries associated with generators that were seen in hospital EDs for the 18-year period from 2004 through 2021. See Table 2. Staff combined diagnosis codes for ED visits with similar benefits and costs: NEISS codes 1 and 6 are combined and identified as "Treated and Released"; codes 2, 4, and 5 are combined and identified as "Hospitalized." There were an estimated 17,569 ED cases classified as Treated and Released between 2004 and 2021, inclusive, due to CO poisoning from the use of generators, and there were an estimated 5,727 classified as Hospitalized.

Table 2. National Estimates of Injuries Associated with Generators Seen in Emergency Departments with Narratives Indicative of Carbon Monoxide Poisoning 2004-2021, By Disposition

NEISS Code	Treatment	Estimated Injuries	Coefficient of Variation	Sample Size	95% Confidence Interval
1	Treated and released, or examined and released without treatment	17,569	0.2612	450	8,575-26,563
6	Left without being seen/Left against medical advice				
2	Treated and transferred to another hospital	5,727	0.2864	149	2,512-8,942
4	Treated and admitted for hospitalization (within same facility)				
5	Held for observation (includes admitted for observation)				
8	Fatality, including dead on arrival, died in the ED, died after admission	*	*	1	*
9	Not recorded	*	*	1	*
	Total	23,318	0.2540	601	11,709-34,927

Source: U.S. Consumer Product Safety Commission National Electronic Injury Surveillance System and Children and Poisoning System, 2004- 2018.
Rows may not sum to the total due to rounding.
*Too few observations to produce an estimate

This estimate should be considered an underestimate because, as a minimum:

(1) Physicians have noted difficulty in correctly diagnosing these injuries. (Aniol, M. J. *Carbon Monoxide Toxicity: The Difficulty in Diagnosing This Leading Cause of Poisoning.* Can Fam Physician. 1992 2123-2134, 2174.) CO poisoning may mimic many nonfatal conditions, including alcohol or drug intoxication, psychiatric disorders, flulike illnesses, and other conditions that can lead to misdiagnosis. Measurement of COHb levels in the victim's blood, which could confirm the poisoning, can also be confounded, based on the time elapsed and any breathing treatment administered that can lower counts before measurement.

(2) Staff is aware that in some incidents reported in the CPSC's in-depth investigation (IDI) reports, first responders transported severely poisoned victims found at the scene directly to a medical facility with a hyperbaric oxygen (HBO) chamber for treatment, rather than to a hospital ED which would not be captured in the NEISS counts and, thus, reduce the estimates.

While the details of the hazard patterns associated with these injuries are largely unknown because the NEISS cases upon which the estimates are based have minimal narratives, it is reasonable to assume that at least some occurred when the generator was operated outside. This is because CPSC has reports of at least 79 deaths from this scenario in the 18-year period so it follows that injuries likely occurred from this scenario as well. Furthermore, staff recently conducted a case study that demonstrates this scenario is not a rare occurrence. This case study is of a rash of incidents of CO from generators operating outside that migrated into consumers' homes in the greater New Orleans area following widespread power outages caused by Hurricane Ida in fall 2021. (See TAB D in this briefing package.) Also, a 3-fatality incident is known to have occurred with a G300-compliant generator operating in this scenario.[4]

[4] Redacted IDI in document ID number CPSC-2006-0057-0110 in www.regulations.gov

C. Deaths in CPSC Databases, and Estimates of Generator-Related CO Deaths and Injuries Seen in EDs If Generators Meeting Either Voluntary Standard Had Been Involved in Those Incidents

There were at least 1,332 fatalities that occurred from 1,009 separate incidents in CPSC's databases as of May 10, 2022, for the 18-year period 2004 through 2021.[5,6] Three of these deaths (from a 2021 single incident) involved a G300-certified generator.[7]

Staff applied the information from the simulations and actual fatal incidents to the NEISS injury estimates provided in Table 2 (and inputs from the Injury Cost Model) to derive the estimates of generator-related CO deaths, hospital admissions, and injuries seen in EDs if generators meeting either voluntary standard had been involved in those incidents instead of the noncompliant (baseline) generators that were involved. This assumes that the distribution of NEISS injuries were similar to the distribution of 511 fatality scenarios used in the NIST simulations. The results are presented in Table 3. Injuries from G300-compliant generators may exceed these estimates because (1) the simulations used in the effectiveness analysis accounted for the scenario of a generator operating only outside in just 2 percent (8 of the 511) of the deaths yet this scenario accounts for 6 percent (79 out of 1332) of the deaths in CPSC's databases and (2) since G300 does not require a CO emission rate reduction, a G300-compliant portable generator running outdoors near an enclosed space that does not shut off presents the same risk of CO poisoning as a noncompliant generator.

[5] Death data for years 2004 through 2010 is from the following report, with an additional death included in 2004 that was reported in the NEISS data but was not previously accounted for: Hnatov, M.V., *Generators Involved in Fatal Incidents, by Generator Category, 2004-2014*, U.S. U.S. Consumer Product Safety Commission, Bethesda, MD, September 2016. (TAB B in Document ID CPSC-2006-0057-0032 in www.regulations.gov)

[6] Death data for years 2011 through 2021 is from the following report, with 5 deaths from 3 incidents in 2011 excluded because they involved stationary generators, which are outside the scope of the draft proposed rule: Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2022. (Document ID CPSC-2006-0057-0108 in www.regulations.gov)

[7] This is the same incident referred to in footnote 4.

Table 3. Estimates Of Generator-Related CO Deaths And Injuries Seen In EDs If Generators Meeting Either Voluntary Standard Had Been Involved, 2004-2021

Outcome for Operators and Collateral Occupants	Baseline vs. Standards		
	Baseline	G300	UL 2201
Fatalities	1332	183.77	0.09
Percentage of deaths averted versus baseline (BL) generators	- -	86.20%	99.99%
Survivors who are hospitalized or transferred to specialized treatment center	7307.67	1,136.54	8.85
Survivors who seek ED treatment and are treated and released	17,568.97	3,227.44	62.21
Survivors who visit doctor/clinic and are treated and released	52,781.62	9,544.73	242.20

D. Staff's Assessment of the Impact of a Longer Run Time on the Estimated Injuries Caused by Generators Meeting UL 2201

Staff notes that, depending on the approach one takes to reduce emissions, generators that meet the CO emission rate of UL 2201 could have longer run times compared to generators with the same fuel tank capacity but do not achieve reduced emissions, With this a possibility, staff evaluated the impact on the deaths and injuries of a run time that was 15 percent longer for UL 2201 generators. To do this, at CPSC staff's request, NIST ran simulations with UL 2201 generators operating with the extended run time in 10 houses and 2 garages that represent 60% of the 511 fatalities in the simulations.[8] These were houses MH1mod, DH45mod, DH21, DH61mod, DH8, DH3, DH34, DH64, DH7, and DH63mod1 and garages GAR2 and GAR3. In terms of allocated deaths, these 10 houses are the two biggest contributors in each of the 5 house types that NIST modeled. This is the same with the two garages out of the three detached garages that NIST modeled. Table 4 summarizes the results in terms of the impact on deaths and the two levels of survivors' injuries from these 12 structures.

Table 4. Comparison Of Deaths And Injuries In 12 Structures With Normal Runtime And Extended Runtime

Fatalities				Hospitalization				Treated and Released			
Normal	Extend	Diff	% Diff	Normal	Extend	Diff	% Diff	Normal	Extend	Diff	% Diff
0	0	- -	- -	2.31	2.41	0.10	4%	13.54	17.60	4.06	30%

[8] See Appendix D in Emmerich, S.J., et al., NIST Technical Note 2202: *Simulation of Residential CO Exposures from Portable Generators with and without CO Hazard Mitigation Systems Meeting Requirements of Voluntary Standards*, February 2022. (https://doi.org/10.6028/NIST.TN.2202r1).

As can be seen in the table, there were no fatalities in either the normal run or the extended run for the same set of 12 structures. Since all 40 structures modelled with UL 2201 generators yielded only three structures having a fractional probability of fatalities, the results of no additional fatalities with the additional 15 percent run time appear reasonable.

The results for the injury level requiring hospitalization also show a negligible difference. From the simulated hospitalizations for the 12 structures only reaching 2.31, the extended run simulation only increased that estimate to 2.41, a net increase of only 0.10 (about 4%). As stated before, the twelve structures that were simulated for the extended run generators represents approximately 60 percent of the fatalities. So, even if the additional 40 percent were added to account for the hospitalizations in all 40 structures, the resultant hospitalizations will, most likely, be less than 0.20, which is less than one additional person being hospitalized.

The results for the injury level of being treated and released show differences that are greater than 1.0. The 12 structures with the normal run time yielded over 13 survivors who would be treated & released. With the extended run simulations, this estimate increases to over 17, an increase of greater than 4. If compensating for the other 28 structures not simulated with the extended run time, staff expects the number of treated and released to still be lower than 10.

To put the results into perspective, if UL 2201 generators with a 15 percent longer run time were involved in the 1,332 fatalities or the 23,318 injuries that occurred in 2004 through 2021, staff expects there would be no fatalities, perhaps a minimal number of hospitalizations and a relatively small number of treated and released cases.

E. Fatal Incidents Involving Generators Operating Outdoors

In the years 2004 through 2021, as of May 10, 2022, at least 79 deaths from 51 incidents were reported to involve the scenario in which a generator was operating outdoors, and its exhaust flowed into a nearby occupied structure. More detail is provided in Table 5 below.

Table 5. Deaths Involving Generators Operating Outdoors by Location, 2004-2021

Location of victim(s)	Incidents	Deaths
House/Mobile Home	22	33
Apartment	1	2
Cabin	1	1
RV/Camper Shell	5	11
Pickup truck with bed-mounted camper	1	4
Camper trailer	16	22
Boat	2	3
Vehicle: Automobile/Truck	3	3
Total	**51**	**79**

TAB B: Preliminary Regulatory Analysis for the Portable Generators Supplementary Notice of Proposed Rulemaking

United States
Consumer Product Safety Commission
cpsc.gov | info@cpsc.gov | 800.638.2772

Memorandum

TO: Janet L. Buyer, Project Manager, Portable Generators Project,
Division of Mechanical and Combustion Engineering,
Directorate for Engineering Sciences

DATE: January 28, 2023

THROUGH: Alexander P. Moscoso, Associate Executive Director
Directorate for Economic Analysis

FROM: Jose Tejeda, Division Director,
Directorate for Economic Analysis

SUBJECT: Preliminary Regulatory Analysis for the Portable Generators Supplementary Notice of Proposed Rulemaking

Executive Summary

The U.S. Consumer Product Safety Commission (CPSC) is considering a draft proposed rule to address the risk of carbon monoxide (CO) poisoning from portable generators. The staff package also evaluates the effectiveness of the CO hazard mitigation requirements in two U.S. voluntary standards for portable generators.[1]

The performance requirements of the draft proposed rule would limit portable generators' CO emissions to a maximum weighted[2] rate of 150 grams per hour (g/h) and require them to shut off before exceeding an instantaneous reading of 400 parts per million by volume (ppmv) or a 10-minute rolling average of 150 ppmv, measured above the generator during compliance testing.[3] Working with CPSC staff, staff at the National Institute for Standards and Technology (NIST) conducted a large number of simulations to assess the efficacy of the maximum limits[4] of these requirements; staff concluded that the draft proposed rule would be highly effective, preventing nearly 100 percent of deaths and injuries from CO poisoning from portable generators.

[1] These voluntary standards are ANSI-approved UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition (referred to as UL 2201), and ANSI-approved ANSI/PGMA G300-2018 Safety and Performance of Portable Generators (referred to as PGMA G300)

[2] The weighted CO emission rate is calculated from the emission rates that are measured while each of 6 different prescribed loads are applied to either the engine or the generator (depending on which of the two the test methods in the draft proposed rule is used) and multiplying each emission rate with a prescribed weight factor and then summing the product of weight factor and emission rate for each of the six loads.

[3] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

[4] The simulations had the generators shut off *when* these concentrations were reached, not before, to reflect what UL 2201 allowed.

Staff identified at least 1,332 deaths from CO poisoning from portable generators that occurred from 2004 through 2021 (Hnatov 2016 and Hnatov 2022). Staff estimated there were 77,658 nonfatal injuries in the same period.[5] The injuries are comprised of 17,569 injuries that resulted in an emergency department (ED) visit, 1,580 injuries resulted in direct hospital admissions, 5,727 injuries resulted in hospital admissions via the ED, and 52,782 injuries resulted in a doctor's or clinic's visit.

The proposed standard would impose the following costs: (1) increased variable costs of producing portable generators with reduced CO emission rates and CO sensors with shutoff capabilities; (2) one-time conversion costs of redesigning existing portable generator models, modifying manufacturing operations, and the recurrent testing costs to validate compliance of each new model with the proposed standard; (3) sensor replacement costs to consumers for failed CO sensors or sensors that have reached end of life; and (4) deadweight loss[6] caused by price increases resulting from increased manufacturing costs. Staff performed a 30-year prospective cost assessment (2024-2053) of these four cost categories and estimated the total annualized cost from the draft proposed rule to be $148.94 million, discounted at 3 percent.[7] Staff estimated the costs per portable generator to be $38.85, discounted at 3 percent.

Staff also conducted a benefits assessment of the draft proposed rule. The benefits assessment accounted for the prevention of deaths and injuries from introducing compliant portable generators, which staff monetized using the value of statistical life (VSL) for deaths and estimates of the cost per type of injury from the CPSC's Injury Cost Model (ICM). Over the 30-year study period, staff estimated the draft proposed rule would prevent 2,148 deaths (nearly 72 deaths per year) and 126,377 injuries (roughly 4,213 injuries per year). The total annualized benefits from the draft proposed rule are $1,046 million, discounted at 3 percent. Staff estimated the per-unit benefits from the draft proposed rule to be $272.84, discounted at 3 percent.

The estimated benefits of the draft proposed rule far exceed its estimated costs. Staff calculates net benefits (benefits less costs) to be $897.06 million on an annualized basis, discounted at 3 percent.[8] The net benefits on per-unit basis are $233.99, discounted at 3 percent. Overall, the draft proposed rule has a benefit-cost ratio of 7.02; that is, for every $1 in direct cost to consumers and manufacturers, the draft proposed rule generates $7.02 in benefits from mitigated deaths and injuries.

[5] Staff estimated nonfatal injuries using its Injury Cost Model (ICM). The ICM generates national estimates from the observed 599 nonfatal injuries from CO poisoning from portable generators through CPSC's National Electronic Information System (NEISS). See Table 2 in Tab A for the sum of sample size in NEISS categories 1, 2, 4, 5, and 6 to find the 599 observed nonfatal injuries. These injuries were recorded as 149 hospital admissions via the emergency department and 450 visits to the emergency department by patients who were subsequently released. The ICM uses the observed incidents in conjunction with information about injury and other factors to extrapolate it into a national estimate that also includes estimates of doctor and clinic visits.

[6] Deadweight loss is the net loss to consumers and producers of the value generated from lost transactions that would have occurred in the absence of the new regulation.

[7] Staff uses a discount rate to incorporate the time value of money during the 30-year study period. In the analysis, staff presents both costs and benefits in undiscounted dollars, discounted at 3 percent, and discounted at 7 percent.

[8] Over the 30-year period, net benefits reach $17.58 billion, discounted at 3 percent.

I. Introduction

The CPSC is considering a draft proposed rule to establish mandatory performance standards and test procedures to reduce the risk of CO poisoning from portable generators with spark-ignited engines fueled by gasoline, liquefied petroleum gas (LPG), or natural gas (NG).

CPSC issued an advance notice of proposed rulemaking (ANPR)[9] in 2006 to determine whether there may be an unreasonable risk of injury and death associated with carbon monoxide from portable generators. The ANPR began the rulemaking under the Consumer Product Safety Act (CPSA). Following publication of the ANPR, CPSC contracted with the University of Alabama (UA) to conduct a low CO emission prototype generator technology development and durability demonstration. CPSC also contracted with NIST to conduct comparative testing of an unmodified carbureted generator and prototype generators in an attached garage of a test house facility and to perform indoor air quality (IAQ) modeling. CPSC staff published a report regarding the results of the UA technology demonstration and NIST's test results.[10] NIST published a report concerning the results of the comparative testing of generators as well as IAQ modeling performed using the test results.[11]

In November 2016, the Commission issued a notice of proposed rulemaking (NPR) to limit the CO emission rates of portable generators to address its CO poisoning hazard.[12] Two years later, in 2018, two voluntary standards for portable generators adopted CO hazard mitigation requirements into their existing standards: ANSI-approved ANSI/PGMA G300-2018 Safety and Performance of Portable Generators, and ANSI-approved UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition (referred to as PGMA G300 and UL 2201, respectively). Both standards require generators to shut off when specified concentrations of CO are present around the generator. UL 2201 also requires a specific, relatively lower CO emission rate, compared to the emission rates of most existing generators.[13]

Staff evaluated the effectiveness of the CO hazard mitigation requirements in the voluntary standards by developing a simulation experiment in coordination with NIST. The simulations replicated 511 fatalities in CPSC's databases. Specifically, the analysis assessed the effectiveness of the CO emission rate and shut off requirements of UL 2201 and the shut off requirements of PGMA G300. Staff's analysis found that under simulated conditions,

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[9] Portable Generators; Advance Notice of Proposed Rulemaking; Request for Comments and Information, 71 FR 74472 (Dec. 12, 2006) (Document ID number CPSC-2006-0057-0001 in www.regulations.gov)

[10] *Technology Demonstration of a Prototype Low Carbon Monoxide Emission Portable Generator* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/staff%20report%20on%20technology%20demonstration.pdf (Document ID number CPSC-2006-0057-0002 in www.regulations.gov)

[11] *NIST Technical Note 1781; Modeling and Measuring the Effects of Portable Gasoline Powered Generator Exhaust on Indoor Carbon Monoxide Level* https://ecpsc.cpsc.gov/pmo/portgen/Shared%20Documents/CPSC%20staff%20cover%20statement%20and%20NIST%20TN%201781.pdf

[12] Information about the 2016 NPR can be found in docket CPSC-2006-0057 on www.regulations.gov. 81 Fed. Reg. 83556 (Nov. 21, 2016).

[13] Staff estimates the emission rate in UL 2201 represents a CO emission rate reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule.

generators compliant with the CO shutoff requirements of the PGMA G300 standard would have averted nearly 87 percent of deaths, with 69 deaths, 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released. Staff's analysis found that under simulated conditions, generators compliant with the CO emission rate and CO shutoff requirements of the UL 2201 standard would avert nearly 100 percent of the deaths, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. Staff concluded that compliance with the CO hazard mitigation requirements in the voluntary standards, in particular UL 2201, would reduce deaths and injuries associated with consumer use of portable generators. PGMA G300 would reduce only some of the deaths and injuries from portable generators.

Staff conducted a review of portable generator models available for sale[14] and found several models with CO detection and shutoff features, as well as a few generators with the added reduced CO emissions feature; however, the number of noncompliant generators is prevalent; particularly, among smaller manufacturers located abroad.

Staff conducted surveys in 2021 and 2022 of manufacturers regarding their production of compliant generators.[15] In both surveys, three manufacturers indicated that most or all their models comply with PGMA G300, and one of these manufacturers also stated its models are compliant with UL 2201. In 2021, four other manufacturers reported that their target compliance rates with PGMA G300 were expected to increase substantially in the next year. However, in 2022, one of these firms responded to the updated 2022 survey and reported compliance rates that fell short of their target established the prior year. Based on this review, the unabated number of incidents, and the market analysis discussed below, staff concludes that compliance with UL 2201 is minimal; while compliance with PGMA G300, although greater, is not sufficient to significantly reduce the risk of injury and death.

A. Draft Proposed Rule

The draft proposed rule would establish performance requirements to reduce the risk of injury or death caused by CO poisoning from portable generators. The performance requirement would limit the CO emission rate of portable generators to a maximum weighted rate of 150 g/h and require them to shut off before exceeding an instantaneous reading of 400 ppmv or a 10-minute rolling average of 150 ppmv, measured above the generator during compliance testing. There are also requirements that would specify aspects of the shutoff system's construction, ability to self-monitor, and tamper-resistance, among others, to help ensure its durability, reliability, and functionality. In addition to these requirements, the rule would also establish CO shutoff notification and labeling requirements to make the consumer aware of the reason for the shutoff and adequately reduce the risk associated with continuing to operate the generator in the way that led to the initial shutoff. The standard would also require a notification marking the direction of the engine exhaust and instructions to direct the exhaust away from the occupied structures. Table 1 summarizes the requirements of the draft proposed rule, and the corresponding requirements in both voluntary standards: PGMA 300 and UL 2201.

[14] Staff obtained a database of 2021 estimated model and product sales from Power System Research, and used these data to support an online search of models for sale on online platforms and stores.

[15] Staff conducted surveys of a subset of large manufacturers in 2021 and 2022. In 2022, in addition to assessing compliance with the voluntary standards, staff obtained cost information regarding the required modifications to make portable generators compliant with each of these voluntary standards.

Table 1: Requirements of the Draft Proposed Rule versus Voluntary Standards

Requirement	PGMA G300	UL 2201	Draft Proposed Rule
Limit weighted CO emissions rate of portable generator to a maximum of 150 g/h, including test methods for verifying compliance		✓	✓
			Same as UL 2201
Require the generator to shut off before the concentration measured above the generator exceeds a threshold for either an instantaneous reading or 10-minute rolling average	✓	✓	✓
	800 ppmv instantaneous & 400 ppmv over 10 minute average	*400 ppmv instantaneous & 150 ppmv over 10 minute average*	Same concentrations as UL 2201
Test Method for Verifying Compliance with CO shutoff requirement	✓	✓	✓
			PGMA G300 with modifications
Sensor/Shutoff System - Maintaining functionality	✓		✓
			PGMA G300 with modifications
Sensor/Shutoff System - Self-monitoring	✓		✓
			Same as PGMA G300
Sensor/Shutoff System - Durability & Reliability	✓		✓
			Same as PGMA G300
Notification, Markings, and Labeling	✓		✓
			PGMA G300 with modifications

1. Effective Date

Under the CPSA, the effective date for a consumer product safety standard must be at least 30 days after promulgation of a final rule and must not exceed 180 days from the date the final rule is published, unless the Commission finds for good cause that an earlier or later effective date is in the public interest. The 2016 NPR proposed an effective date one year after publication of the final rule for larger generators and 3 years for smaller generators to allow enough time to comply, due to possible significant modifications associated with the use of closed-loop fuel injection and fuel control closer to stoichiometry[16], such as adding cooling fins and a fan, which

[16] Stoichiometry refers to the exact ratios of oxygen and fuel chemicals called for by the chemical reactions to fully burn the fuels with no shortage or excess of oxygen.

staff considered at the time likely would be needed to meet the proposed CO emission rates in the NPR. Significant changes have occurred since the NPR which are described in section III.F of the briefing memorandum.

For this draft proposed rule, staff recommends an effective date of 180 days from publication of the final rule in the Federal Register.

Staff recognizes that failure to provide enough time for manufacturers to comply with the draft proposed rule could result in significant costs such as:

- Shortage Cost to the Supply Chain. An earlier effective date may make it unfeasible for some manufacturers to comply with the draft proposed rule. Manufacturers that are unable to produce a compliant product or are not yet able to produce enough to meet typical demand would likely cause a shortage of product. The inability to produce enough portable generators would generate revenue loss to all levels of the supply chain – suppliers, producers, intermediaries, transporters, wholesalers, and retailers. There could also be additional cost such as penalties from broken or unfulfilled contracts due to the shortage. These costs could be significant. A report by The Economist Intelligence Unit found that a plurality of U.S. manufacturers said supply chain disruptions cost between 6 and 10 percent of revenue. Using a midpoint of 8 percent, that would equate to over $168 million[17] in potential costs; however these costs could be lower because the portable generator industry has endured shortages in the recent past due to extreme weather events[18] [19] and may be more prepared for possible shortages than other industries. Some or most of this revenue may be an economic transfer because some consumers would purchase other products or services, but not all and that fraction could still be a significant cost. Additionally, the individual firms and brands would still feel the full impact of the revenue loss which could trigger costly business decisions by management (e.g., layoffs). This is discussed in detail further in this section.
- Shortage Cost to the Consumers. A shortage of product would deny its consumers of their preferred product. The cost to consumers is a loss of economic utility and potentially a financial loss from buying a more expensive substitute. Consumers who wish to purchase a portable generator but cannot because of a shortage would either purchase a substitute product, wait until portable generators become available again, or forego the purchase altogether. Consumers could purchase another product or service (e.g., driving from home and staying in a hotel) that is more expensive and have less utility than a portable generator. Those consumers who wait until the product becomes available again would have their utility for the product reduced because of the delay. Consumers who drop out of the market may have to incur costs associated with enduring days without power.

[17] $168 million = 8% × $2.1 billion of reported revenue.

[18] Willis, Kara, "Fear of power outages lead to generator shortage", June 16 ,2021, *12News*, https://www.12newsnow.com/article/weather/fear-of-power-outage-due-summer-heat-and-gulf-disturbance-leads-to-generator-shortage/502-58aeb7a3-fd9e-4928-91fb-41dd4afb5a16

[19] Garcia-Buckalew, "Icy weather on the way and no portable electric generators to be found", February 1, 2022, *KVUE-ABC*, https://www.kvue.com/article/news/local/texas/portable-electric-generator-shortage/269-4b48209a-e692-4d67-b745-8744960f539b

- Loss of benefits. While not a cost compared to the status quo, a shortage would reduce the expected benefits estimated in this regulatory analysis (Table 18 and Table 19). Each portable generator not available because manufacturers were unable to be produce compliant products by the effective date means there are fewer potential benefits from the draft proposed rule. This is especially the case if consumers choose to drop out of the market and continue to operate noncompliant products that pose a greater risk of CO poisoning.

- Unforeseen quality control issues. Some manufacturers may be able to produce compliant products at an earlier effective date than 180 days. However, an expedited process may lead to unforeseen mechanical or operational issues. Staff does not assume manufacturers would knowingly deliver faulty products, but a condensed production and testing timeline could increase the risk of latent issues with the compliant portable generators. These issues would potentially cost consumers by inconveniencing them with operational issues, and potentially costing manufacturers if a recall is needed, including any harm in reputation.

- Displaced companies and their employees. A potentially costly effect from shortages is sustained or permanent harm to business operations. This could include a company reacting to a loss of revenue from shortages by laying off employees or, for some small businesses, liquidating completely. In either scenario, the laid off employees and their families incur the cost of unemployment which includes loss of income and the intangible costs of anxiety due to financial insecurity. The Bureau of Labor Statistics reports the average wage of an engineer or other machine assembler to be $48,110 per worker per year.[20] Prolonged unemployment from many laid off workers could cost millions of dollars. Finally, the loss of income from these households can have a ripple effect to the local economy depending on the number of unemployed and their geographical concentration.

The proposed effective date would help ensure that manufacturers have adequate time to properly transition to the new rule and design and test new products before they are placed into commerce. Staff recommends that the Commission seek comments on the effective date, in particular by suggesting that any parties urging a later effective date come forward with specific facts to explain the basis for their assertion that more than 180 days is needed.

2. Stockpiling

The draft proposed rule includes an anti-stockpiling provision[21] that would prohibit a manufacturer from "stockpiling" or substantially increasing the manufacture or importation of noncompliant portable generators between the promulgation of the final rule and the effective date. The provision would prohibit the manufacture or importation of noncompliant products at a rate that is greater than 120 percent at which the firm manufactured and/or imported portable generators during the base period. The base period is the average monthly manufacture or

[20] Bureau of Labor Statistics, "Occupational Employment and Wages, May 2021; 51-2031 Engine and Other Machine Assemblers", https://www.bls.gov/oes/current/oes512031.htm

[21] According to Section 9 paragraph (g)(2) of the CPSA, CPSC is required to consider whether to prohibit stockpiling from the date of promulgation of the rule to the effective date of the rule. Stockpiling is defined as manufacturing or importing a noncompliant products which is significantly greater than the rate at which such products were produced or imported during a base period. The base period is defined as the 12 months preceding promulgation of the rule.

import volume for any continuous 180-day period within the last 12 months immediately preceding the month of promulgation of the final rule.

Portable generator sales have historically been volatile between year-to-year[22] and can be significantly affected by extreme weather events.[23] [24] Staff was unable to find observed data of recent sales. Therefore, staff recommends a base period of 12 months using the general forecasting assumption that the most appropriate predictor of sales – in lieu of specific data – is the previous year's sales. Staff requests public comment on recent data of portable generator sales to help inform this assessment. Staff proposes that the Commission set the rate of the manufacturing or importing to 120 percent of the base period to allow for flexibility in a volatile market and account for extreme weather events. A 120 percent rate has been the upper limit for other CPSC rules.

Due to the unusual volatility of sales of portable generators based on unpredictable weather events, staff recommends that a 120 percent of the average monthly manufacture or import volume for any continuous 180-day period within the last 12 months preceding the promulgation of the rule would help ensure that the demand for portable generators can be met without creating a prohibitive amount of excess noncompliant inventory that would undermine the rule's effectiveness.

B. Preliminary Regulatory Analysis

Pursuant to section 9(c) of the Consumer Product Safety Act, publication of a proposed rule must include a preliminary regulatory analysis containing the following:

(1) a preliminary description of the potential benefits and costs of the proposed rule, including any benefits or costs that cannot be quantified in monetary terms, and an identification of those likely to receive the benefits and bear the costs;

(2) a discussion of the reasons any standard or portion of a standard submitted to the Commission under subsection (a)(5) was not published by the Commission as the proposed rule or part of the proposed rule;

(3) a discussion of the reasons for the Commission's preliminary determination that efforts proposed under subsection (a)(6) and assisted by the Commission as required by section 5 (a)(3) [of the CPSA] would not, within a reasonable period of time, be likely to result in the development of a voluntary consumer product safety standard that would eliminate or adequately reduce the risk of injury addressed by the proposed rule; and

(4) a description of any reasonable alternatives to the proposed rule, together with a summary description of their potential costs and benefits, and a brief explanation why such alternatives should not be published as a proposed rule.

An overview of the portable generators market can be found in section II of this memorandum. A preliminary description of the potential costs and benefits of the draft proposed rule can be

[22] The average yearly growth from observed sales (1996-2014) is 12.60% with a standard deviation of 40.58%.

[23] Willis, Kara, "Fear of power outages lead to generator shortage", June 16 ,2021, *12News*, https://www.12newsnow.com/article/weather/fear-of-power-outage-due-summer-heat-and-gulf-disturbance-leads-to-generator-shortage/502-58aeb7a3-fd9e-4928-91fb-41dd4afb5a16

[24] Garcia-Buckalew, "Icy weather on the way and no portable electric generators to be found", February 1, 2022, *KVUE-ABC*, https://www.kvue.com/article/news/local/texas/portable-electric-generator-shortage/269-4b48209a-e692-4d67-b745-8744960f539b

found in sections III and IV, respectively. The analysis of benefits relative to costs is presented in section V. As discussed earlier, two voluntary standards for portable generators were revised in 2018 to include CO hazard mitigation requirements. The draft proposed rule is based on requirements of both the UL 2201 and PGMA G300 standard, with modifications to ensure the effectiveness of the draft proposed requirements, which are discussed in tabs E and F of this briefing package. PGMA G300 is discussed in this document as a less stringent alternative to the draft proposed rule. A discussion of the voluntary standards is presented in section VI. Finally, a discussion of the alternatives to the draft proposed rule can be found in section VII.

II. Market Information

A. The Product

The draft proposed rule provides requirements for portable generators powered by small handheld[25] and non-handheld spark ignition (SI) engines, which are fueled by gasoline, liquefied petroleum gas (LPG), or natural gas (NG).

Generators within the scope of the draft proposed rule provide receptacle outlets for AC output circuits and are intended to be moved, although not necessarily with wheels. Products that would not be covered by the draft proposed rule include permanently installed stationary generators, 50 hertz generators, marine generators, generators installed in recreational vehicles, generators intended to be pulled by vehicles, and generators intended to be mounted in truck beds. Generators powered by compression-ignition (CI) engines fueled by diesel also are excluded from the scope of the draft rule. See TAB E of this briefing package for more details. Generators used as part of welding machines available to consumers are, however, required to comply with the draft proposed rule.

The portable generators within the scope of this draft proposed rule are commonly purchased by household consumers, particularly to provide electrical power during emergencies (such as power outages caused by storms); when power to the home has been shut off or it is needed at locations around or away from the home that lack access; and for recreational activities such as camping. Built-in wheels or optional wheel kits are often available for heavier, more powerful units (e.g., those with 3 kW power ratings or more).

Portable generators have historically been the leading product among all engine-driven tools (EDTs) to cause non-fire CO poisoning deaths and injuries to consumers, accounting for over 90 percent of the 900 reported fatalities associated with all EDTs during the period 2011 to 2021, and 88 percent of the 710 EDT incidents that occurred in this period (Hnatov 2022). The pattern of deaths and injuries has not subsided over time. While data collection is ongoing, the number of CO deaths caused by portable generators in year 2020 is likely to exceed the highest number of annual deaths (103 deaths) that were reported in 2005.

The expected useful life of portable generators is largely a function of engine size, loads placed upon the unit, hours of use, and appropriate maintenance and storage. Portable generators purchased primarily for household backup power, and mainly used during occasional or rare power outages could have longer useful lives than products used with higher intensities around households or recreational settings. An evaluation of data on historical sales in relation to

[25] As defined by the Environmental Protection Agency (EPA) at 40 C.F.R. § 1054.801.

surveys of product ownership suggests an expected useful product life of 11 years.[26] This estimate is close to the average product life of similar consumer durables.[27]

New series of portable generator models are introduced every year. Staff estimates that the average shelf life (period when a particular model is on the market) for a specific model is 12 years. Staff assumes the market has reached a steady state in the number of models available for sale. Under this assumption, firms introduce new models to essentially replace retiring models.

Consumers purchase portable generators primarily through retail stores and online retailers. Staff collected retail prices of 108 portable generators of various sizes from top selling manufacturers through online retailers and other sources. The weighted average price across different sizes of portable generators from that sample of models is $1,000.[28]

B. Current Market Trends for Portable Generators

Staff identified 110 manufacturers of portable generators sold in the United States in 2021.[29] The largest 10 firms by volume sold accounted for roughly 70 percent of sales. Top sellers fluctuate yearly, but a majority of the top ten firms each year are U.S. based companies. In recent years, portable generators manufactured in the U.S. represented between 55 and 60 percent of all portable generator sales.[30]

Staff used multiple sources to estimate portable generator sales in 2021 of 2.1 million units,[31] which results in total revenue for the portable generator industry of $2.1 billion.[32] Staff estimated the total number of portable generators in use to be 21.46 million in 2021. Staff

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[26] A product life of 11 years inputted into CPSC product population model also generates estimates of products in use that are consistent with industry estimates of ownership, such as those provided by Generac, a portable and stationary generator manufacturer, that reportedly estimated that about 12 percent of households had portable generators in 2013 (roughly 15 million products in use), up from 10 percent in 2010. (Hill, 2013)

[27] Lutz, J., Hopkins, A., Letschert, V., Franco, V., and Sturges, A., "Using National Survey Data to Estimate Lifetimes of Residential Appliances", *Ernest Orlando Lawrence Berkley National Laboratory*, October 2011, Tables 14 presents similar lifetime estimates for room air conditioners and water heaters; that is, between 9 and 13 years, both from this study and from Appliance Magazine.

[28] Current weighted average prices of portable generators were estimated using average prices by engine size. The average prices by generator size are as follows: under 2 kW, $436.17; between 2 kW and 3.5 kW, $737.91; under 9 kW but above 3.5 kW, $1.129.79; and above 9 kW, $2,065.17 (the full range of portable generators prices goes from $149.00 to $6,649.00). Based on sales data from Power System Research (see note below), staff estimated the market shares of portable generators by size, as follows: under 2 kW, 10.11 percent; between 2 kW and 3.5 kW, 28.51 percent; under 9 kW but above 3.5 kW, 55.77 percent; and above 9 kW, 5.61 percent.

[29] The number of manufacturers supplying portable generators to the United States has fluctuated significantly over the years, based on the market information provided by Power Systems Research (see footnote below). In 2012, the number of manufacturers was about to reach two hundred, but since them a trend toward industry consolidation seems to have emerged.

[30] Staff purchased a shipment volume database from Power Systems Research, a vendor specialized in the portable generator market. This database was used to estimate market share of subsets of products, and global sales trends for the portable generator industry.

[31] Staff developed the 2021 sales using market share and sales estimates provided by three large US manufacturers, along with 2021 sales volumes by portable generator model, provided by Power System Research.

[32] This estimate was generated multiplying the average price per generator of $1,000 by the 2021 sales volume of 2.1 million units.

calculated in-use products using historic sale estimates along with a statistical distribution of product failures centered around the product's average lifespan.[33] Staff made efforts to ensure the estimates of products in use were within a normal statistical range from similar estimates developed by industry in the past.[34]

Staff also produced estimates of the number of new portable generator models introduced each year, as well as the total number of models for sale in any given year within the time horizon of the analysis. For this purpose, staff estimated the number of individual models available for sale each year from the Power Systems Research sales dataset. In 2021, there were a total of 1,355 models for sale in the U.S. Staff then estimated a model retirement rate of 8.3 percent per year,[35] which results in 112 models being retired in 2021. Those models were replaced with a total of 118 new models, for a net gain of six additional models available for sale in 2021.

C. Future Market Size for Portable Generators

Consumer demand for portable generators fluctuates annually with power outages, which are generally caused by hurricanes and other storms along the Gulf and Atlantic coasts, or by winter storms in other areas. Power outages or the presence of storms create periods of increased demand for portable generators that tend to be followed by periods of reduced demand, because the purchases in the prior period saturated a portion of the market demand. This cyclicality of demand can impact the industry, whose inventories and orders vary along the same continuum. Manufacturers have in the past highlighted the importance of this pattern of sales in annual corporate reports and other market reports, as well as the impact of weather-related power outages in their commercial activity.[36]

In spite of this cyclicality of demand, staff projected future sales at a rate of growth that is unrelated to the occurrence of specific weather events.[37] Staff postulates that the sales of portable generators are linked in the long run to the growth in the number of households in the U.S.; however, due to the increased frequency of weather events in the last decades and the predictions of more frequent and severe storms in the future,[38] staff expects demand for portable generator to grow more quickly than the expected growth in the number of households over time.

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[33] Staff used a statistical distribution to estimate failures of portable generators. The statistical distribution enables the estimation of the number of products that failed, and those that survived a number of years after sold for the first time. The distribution used was a two-parameter gamma distribution with shape 11 and scale parameter 1 corresponding to a mean portable generator lifespan of 11 years.

[34] See prior footnote that references Lutz, et.al.

[35] This rate is the inverse of the average shelf lifespan of portable generator models.

[36] For instance, Briggs & Stratton, a leading manufacturer of engines used in the production of generators, noted that in 2007, the company experienced a 66% reduction of engine shipments for portable generators due to the absence of weather events leading to power outages. Likewise, 1999 is the peak year in record with a total of 2.2 million portable generator shipments due to widespread concerns over the possible impact of Y2K in disrupting power supplies.

[37] The reasons for this departure from the pattern of demand are twofold: first, the importance of forecasting sales lies in capturing the overall trend not only in annual consumer purchases, but also of products in use, rather than the actual year-on-year fluctuations; and second, forecasting the timing of weather events is clearly infeasible.

[38] See the U.S. Environmental Protection Agency's Climate Change Indicators at Climate Change Indicators: Weather and Climate | US EPA.

To estimate the rates of growth in portable generator sales, staff collected population growth rates as forecasted by the Census Bureau several decades into the future. The number of households has been growing faster than population because one-person and two-person household have become more prevalent – representing 63.5 percent of all households in 2021, up from 58.6 percent in 2000, and from 50.2 percent in 1975. In the period from 2000 to 2021, the number of households have been growing 1.26 times faster than the population – population growth rate of 0.78 percent versus household growth rate of 0.99 percent. In the same period, the portable generator market has grown at an average rate of 2.1 percent, or 2.13 times faster than households. Staff applied these multipliers to the Census Bureau implied population growth rates to estimate the rate of growth of portable generator sales for the 30-year period of analysis, as displayed in Table 2.

Table 2: Growth Rate of Portable Generator Sales, 2022-2053

Growth Rates in Sales	Population Growth Rates	Household Growth: 1.26 × Population Growth	Sales Growth: 2.13 × Household Growth
2022 - 2030	0.60%	0.75%	1.60%
2030 - 2040	0.46%	0.58%	1.24%
2040 - 2050	0.37%	0.46%	0.98%
2050 - 2053	0.29%	0.37%	0.78%

Figure 2 displays projected portable generator sales from 2024 through 2053 in the absence of the draft proposed rule and distinguishes their compliance with either of the voluntary standards: PGMA G300 or UL 2201.[39] Based on information provided by manufacturers and in market research, staff estimates a 30 percent compliance rate with PGMA G300's sensor and shutoff requirements. One sixth of those PGMA-compliant units (or 5 percent of the total) are estimated to also be compliant with the emissions requirements of UL 2201. Staff assumed that in the absence of the draft proposed rule those compliance rates would continue into the future.

[39] It is worth noting that throughout the analysis, staff assumes that if a generator complies with the emission requirements included in UL 2201, it also complies with the sensor / shutoff requirements from PGMA G300; therefore, some portable generators comply with the sensor/shutoff requirements only, while others would comply with both sensor/shutoff and emission requirements.

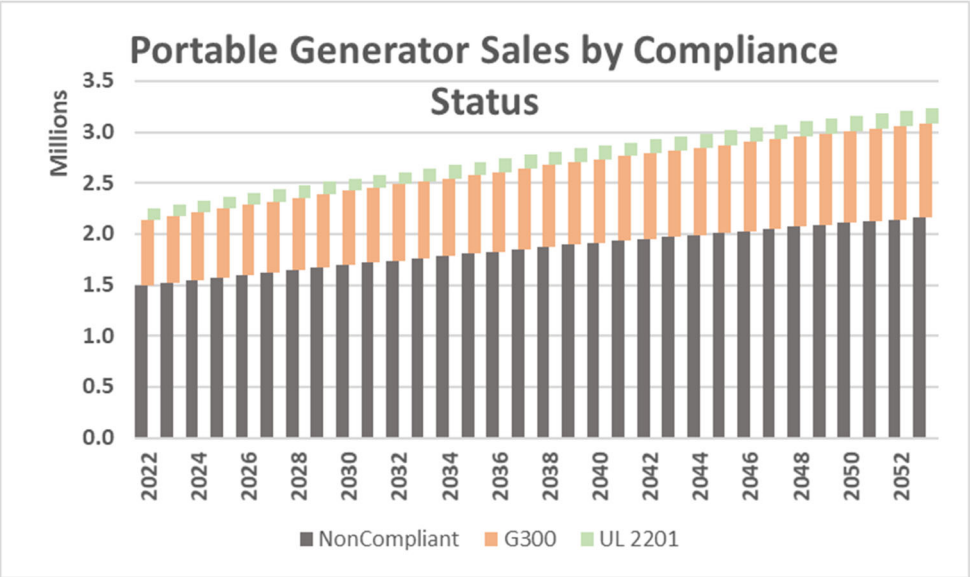

Figure 2: Portable Generator Forecast of Sales By Compliance Status, 2024 - 2053

Figure 2 shows that the number of portable generators sold per year is expected to reach three million units by 2045, and close to 3.25 million units by the end of the period of analysis.

As previously mentioned, portable generators have an expected product life of 11 years; for instance, a portable generator purchased in 2022 might be in use every year from 2022 until 2033, more or less. Staff used forecasted sales and the expected product life with a statistical distribution to estimate the likelihood of their continued use by consumers, and as a result produced an estimate of the total number of portable generators in use every year during the 30-year period of the analysis. Figure 3 shows the estimated number of products in use without the implementation of the draft proposed rule.

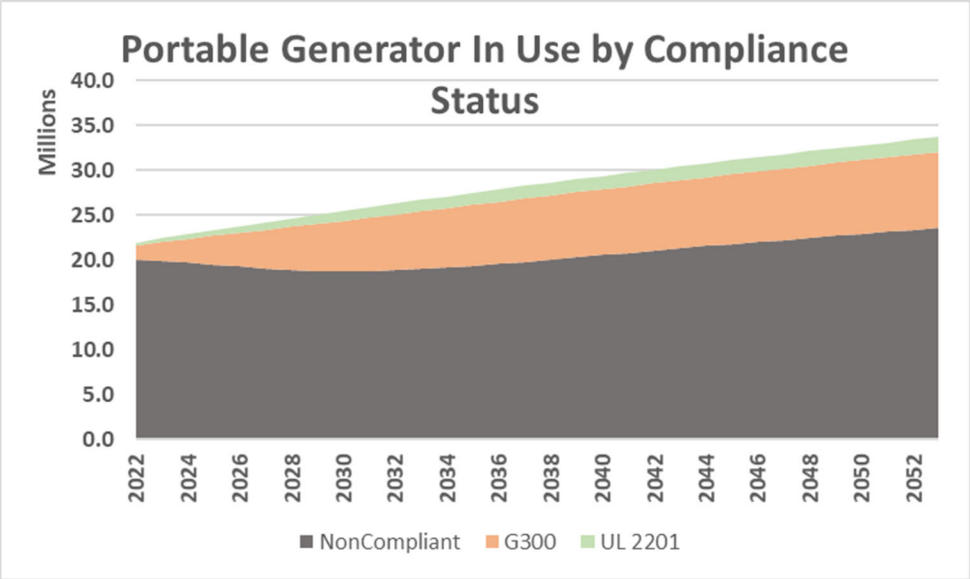

Figure 3: Forecast of Portable Generators in Use by Compliance Status, 2022 - 2053

Figure 3 shows that the number of portable generators that would be in use without the draft proposed rule are roughly 22 million in 2022, and expected to grow by more than 50 percent

over the next 30 years. By 2053, staff estimates that the total number of portable generators in use will reach nearly 34 million. The share of noncompliant portable generators decreases over time, from 91.4 percent in 2022, to 70 percent by 2053, matching the share of noncompliant portable generators continuing to be sold on a year-by-year basis, as older noncompliant units are retired.

Staff also estimated the number of models available for sale each year during the period of analysis, as well as the number of new models introduced each year. Staff concluded that the number of models has essentially reached a steady state and that the number of new models introduced each year replaces models being retired at a rate of 8.3 percent per year. Staff estimates that approximately 113 or 114 new portable generator models are introduced each year. The number of models available for sale will reach 1,414 in 2023, and only 1,424 in 2053.

III. Preliminary Regulatory Analysis: Cost Analysis

This section discusses the costs that the draft proposed rule would impose on industry and consumers. The draft proposed rule seeks to establish mandatory standards that require the redesign and testing of portable generator models to limit the level of CO emissions produced and to shut off before the CO concentration measured above the generator during compliance testing exceeds specified limits. Staff estimated the full cost of the draft proposed rule based on the assumption that 100 percent of manufacturers adopt this solution, and only sell fully compliant portable generators starting in 2024. These costs are measured incrementally and from a baseline where the draft proposed rule is not in effect, but the numbers of portable generators compliant with either UL 2201 or PGMA G300 continue to grow (see Figure 3). This section will frequently mention the baseline (without the rule) scenario and the "with the draft proposed rule" scenario.

There are four cost components discussed under this cost section: (1) the increased variable costs of producing portable generators with reduced CO emission rates and CO sensors with shutoff capabilities; (2) the one-time conversion costs of redesigning portable generator models, modifying factory operations, and the recurrent cost of testing for compliance; (3) recurrent cost of CO sensor replacements by consumers; and (4) the deadweight loss caused by price increases resulting from increased manufacturing costs.

The time span of the cost analysis covers a 30-year period that starts in 2024, the expected year of implementation of the draft proposed rule. This cost analysis presents all cost estimates in 2021 dollars, and also produces the present value of those future costs by discounting them at 3 and 7 percent.[40]

The subsections below provide a general description of each cost category and the per-unit cost. The last subsection presents costs over the 30-year study period. Staff presents the total costs of the draft proposed rule in both annualized and per-unit terms. An annualized output converts the aggregate costs over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the costs among different rules or policy alternatives that may have different timelines; or those that have similar timelines but

[40] Discounting future estimates to the present allows staff not only to consider the time value of money, but also the opportunity cost of the investment, that is, the value of the best alternative use of funds.

costs for one are front-loaded while the other's maybe back-loaded.[41] A per-product metric expresses the costs from the rule in one unit of product. This metric is helpful when assessing the impact in marginal terms; for example, comparing costs to an increase in retail price. Staff presents both these metrics to provide a holistic perspective of the impact from this draft proposed rule.

A. Increased Manufacturing Cost of Upgraded Portable Generators

Manufacturers would be required to modify the design and manufacturing of portable generators to limit the amount of CO emissions produced while the units are in use, as well as to include sensing capabilities to detect CO concentrations in excess of specified thresholds, and then shutting off the generator. Portable generator manufacturers would incur costs from component parts, as well as additional labor and overhead. These are per unit costs that would increase with the volume of production.

Staff conducted a survey of large U.S. portable generator manufacturers to assess the per-unit cost of upgrading portable generators to comply with both the reduced CO emission and CO sensing and shutoff requirements. The range of cost provided by these manufacturers is presented in Table 3 and Table 4. The estimates in these tables represent the cost of making a noncompliant generator compliant with each requirement. The second column in each table indicates whether the manufacturer is currently producing portable generators that are compliant with the emission requirement of UL 2201, or the sensing and shutoff requirement of either standard.

Table 3: Incremental Unit Cost - Reduced Emissions Requirement

Incremental Unit Cost for Reduced Emission Requirement	Producing Compliant Generators	Low	High	Mid
Manufacturer One	Yes	$15.00	$30.00	$22.50
Manufacturer Two	No	$135.00	$245.00	$190.00
Manufacturer Three	No	$250.00	Significantly higher	

Table 4: Incremental Unit Cost – CO Sensing and Shutoff Requirement

Incremental Unit Cost for CO Sensing and Shutoff Capability	Producing Compliant Generators	Low	High	Mid
Manufacturer One	Yes	-	-	$10.00
Manufacturer Two	Yes	$19.76	$24.97	$22.37
Manufacturer Three	Yes	$23.75	$30.88	$27.31

[41] The timing of costs along the period of study affects the present value of costs when considering the time value of money. Costs incurred several years into the future are discounted more heavily than costs realized in the short-term.

As described above, some of these estimates are based on actual per-unit production cost achieved by manufacturers. Other estimates reflect the pre-production perception of managers with respect to manufacturing costs they would likely face. Staff concluded that the lower costs estimates are representative of what industry can achieve after the productivity gains from economies of scale and learning take place. Staff used manufacturers' estimates[42] to develop cost improvement curves[43] that allow for further productivity gains as the volumes of production increase and the manufacturing systems are tested by competition.[44] Staff used these cost improvement curves to estimate the average cost of production that correspond to the volumes sold each year in the time horizon of the analysis. The same curves are used to estimate average unit cost in both scenarios: the baseline scenario with no rule and the scenario with the implementation of the draft proposed rule in 2024.

Figure 4 illustrates the cost improvement curves for CO emission reduction and CO sensing & shutoff technologies. These cost improvement curves include a markup above the cost provided by manufacturers in Table 3 and Table 4 that accounts for additional cost components along the supply chain, not explicitly considered elsewhere in this assessment.[45] As shown in the figure below, when the portable generator industry achieves a production of two million units, the average cost for CO emission reductions and CO sensing and shutoff technologies are $37.80 and $16.80 per portable generator.[46]

[42] CPSC is bound by a confidentiality agreement with survey participants, so the names of the manufacturers cannot be disclosed.

[43] The traditional definition of "learning curves"—or more properly in this case "cost improvement curves"—is centered on the observation that the cost per unit is reduced by a certain percentage every time the number of units produced doubles. The most cited models are derived from T.P. Wright (1936 - cumulative average unit cost) and J.R. Crawford (1944 - specific unit cost). The functional form in both models is: $C(X) = AX^{\propto}$, where C(X) is the cost function at level of production X, A is the cost of the first (theoretical) unit, X is the number of units produced, and α is the slope. In Wright's model, C(X) is the cumulative average cost (the form used here); while in Crawford's model, C(X) is the cost of the last unit produced.

[44] Staff estimates the slope of the cost improvements curves for the CO emissions requirement and CO sensing and shutoff requirements using the data provided by manufacturers. The estimated slopes are respectively -0.15716 for the CO emissions requirement, and -0.06271 for the CO sensing and shutoff requirement. These slopes correspond to cost improvements of 4.3 percent and 10.3 percent per doubling of production volumes. The estimation of the slopes uses the average of the two highest cost inputs as representative of the initial cost of production, and the lowest cost is conservatively used as the average cost when two million units (the 2021 sales volume, rounded to the nearest million) are produced per year.

[45] The markup includes incremental cost components not explicitly included in the analysis, such as potential additional packing and shipping cost, new product manuals and documentation, additional distribution costs associated with changes in merchandising, marketing, promotion, advertising, etc.; and, perhaps most prominently, additional profits for retailers, wholesalers, distributors, and even manufacturing firms, Arguably, if profits are the largest component of the markup multiplier, instead of including it within the manufacturing costs, the markup could be added later during the determination of the price impacts from the rule. However, in order to produce more conservative estimates (higher costs), staff decided to include the markup at this stage of the process; therefore, internalizing profits and other relatively small cost components as additional elements of manufacturing costs. The markup used for the portable generator industry is a proxy value obtained from multiple sources, as 68 percent, or a 1.68 multiplier over manufacturing costs.

[46] The averages costs are the same as the per-unit cost provided to staff during the surveys by the lowest-cost U.S. manufacturer, and then multiplied by the 1.68 markup multiplier.

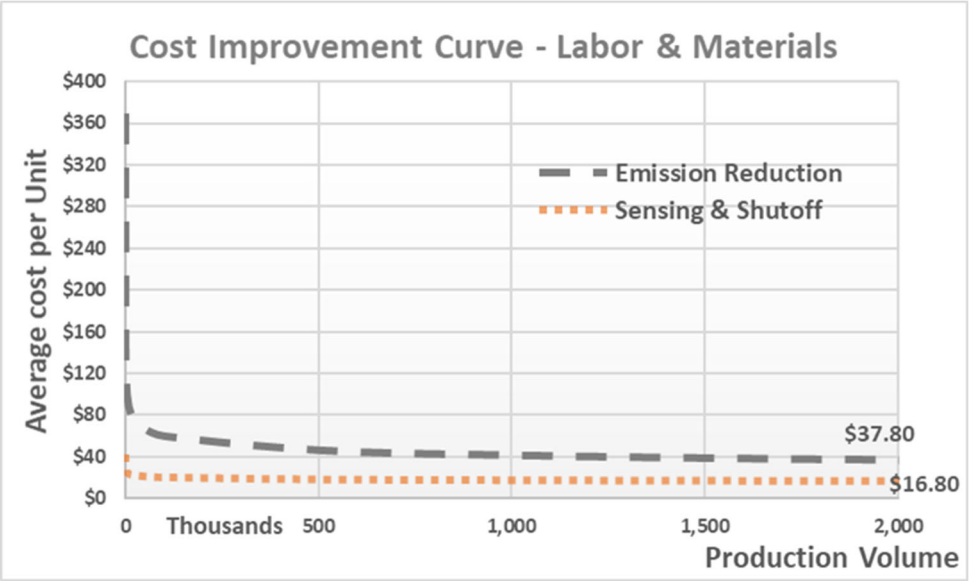

Figure 4: Average Unit Cost by Production Volume - Labor and Materials

B. Model Redesign, Conversion, and Testing

Manufacturers of portable generators would incur fixed one-time costs of converting all portable generator models, and the manufacturing process of those models, to introduce CO emission reduction and sensing and shutoff features. In addition, manufacturers would have to test each new model to validate compliance with the standard.

As part of the survey of large U.S. manufacturers, staff received cost information on conversion and testing costs. These costs can largely be categorized as: Capital Conversion, Model Conversion, and Testing Costs. Capital Conversion Costs are one-time costs to bring production facilities into compliance. Model Conversion Costs are also a one-time investment in research, development, materials, and other costs to bring model designs into compliance. Testing Costs are recurrent expenses incurred by the manufacturer to validate the compliance of new designs with the standards.

Some manufacturers provided the total capital cost of modification and the number of models impacted, while others provided the total cost of conversion per model. Staff was not able to separate the portion of cost that correspond to capital versus model conversion, so these are lumped together and presented as conversion costs per portable generator.[47] The cost of testing is also presented on a per-model basis. All figures displayed in Table 5 are in 2021 dollars.

[47] Generally, manufacturers surveyed provided a fixed investment associated with the required modifications, and the number of models these modifications were implemented on. One manufacturers provided a fixed investment for the modification of a number of models, plus additional cost to adapt those modifications to each specific model. Other manufacturer only provided the average cost per model impacted by the modification. To standardize the inputs provided by these different manufacturers, staff chose to convert all estimates provided into costs per model upgraded.

Table 5: Conversion and Testing Costs for Portable Generator Models

Reduced CO Emissions and CO Sensing and Shutoff Features	Compliant Generator Models Assessed	Low	High	Mid
Model Conversion Costs per Model				
Manufacturer One	7			$147,000
Manufacturer Two	30	$400,000	$500,000	$450,000
Testing Costs per Model				
Manufacturer One	Yes			$5,400
Manufacturer Two	No			

The conversion estimates in Table 5 come from two sources: one is an actual conversion cost experienced by a manufacturer producing compliant models; while the second is an initial investment plan that reflect manager's expectations of potential conversion costs. Staff used the former as representative of what the industry can achieve with conversion costs through economies of scale and learning, while the latter is used as an estimate of the theoretical conversion cost for the first model. Staff built a cost improvement curve around these estimates,[48] which then was used to estimate average unit cost in both scenarios; the baseline and the scenario with the implementation of the draft proposed rule.

There is an important difference between baseline and the draft proposed rule with regards to conversion costs. In the baseline, conversion costs do not occur as a single one-time investment because there is no rule that forces all manufacturers to convert at the same time; instead, there are annual conversions that occur over time as a segment of the market adopts either voluntary standard. Figure 5 presents the number of models updated annually under the draft proposed rule and the baseline. Staff developed for this analysis a forecast of model conversion costs in the baseline that results in baseline conversion costs per model that are higher than the equivalent conversion costs with the draft proposed rule.

[48] Staff estimates the slope of the cost improvements curves for the conversion of models into models compliant with the CO emissions and CO sensing and shutoff requirements using the data provided by manufacturers. The estimated slopes is -0.1962, which corresponds to cost improvements of 12.7 percent per doubling of production volumes.

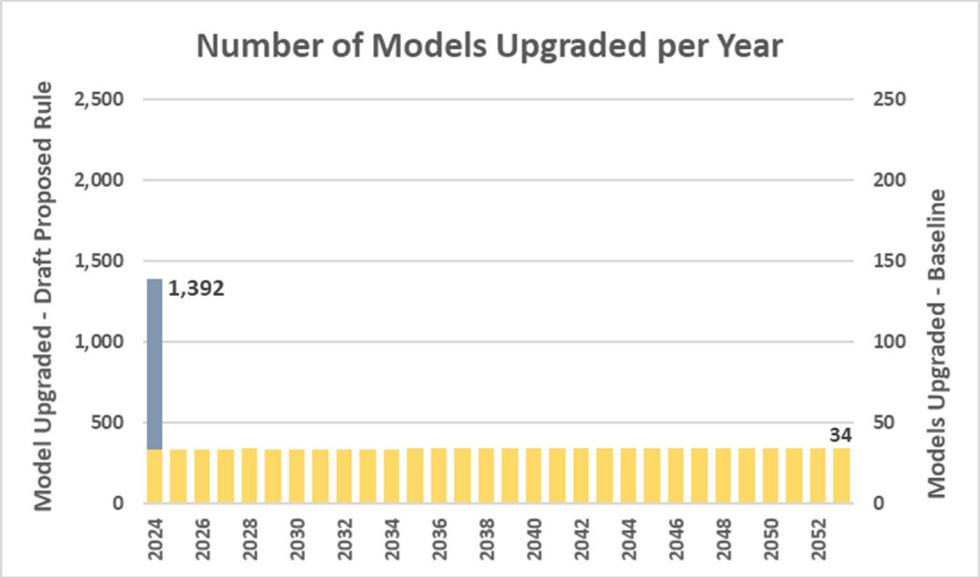

Figure 5: Number of Models Upgraded – Draft Proposed Rule vs Baseline

Staff developed the cost improvement curve for model testing using an estimate provided by a single manufacturer. Since there is a single point estimate for the cost of testing for compliance verification, staff assumed that the first test would cost twice as much as the estimate provided by the manufacturer.[49] Then, staff conservatively[50] assumed that the single point estimate provided by the manufacturer would correspond to a relatively large number of tests, and used it to estimate the slope of the cost improvement curve.[51] Staff used this cost improvement curve to estimate the testing cost per model in both the baseline (without the rule) scenario and scenario with the implementation of the draft proposed rule.

Figure 6 illustrates the cost improvement curve for model conversion and model testing. These cost improvement curves include a markup above the cost provided by manufacturers in Table 5 to account for cost components along the supply chain not explicitly considered elsewhere.[52] As shown in the figure, when the annual number of models reaches a thousand, the cost of model redesign drops to $195.01 thousand and the cost of model testing to $7.84 thousand.

[49] CPSC's subject matter experts (SMEs) provided the range for testing costs for a first model.

[50] From CPSC's perspective, a conservative estimate is one that produces higher costs and lower benefits.

[51] Staff assume that the testing cost per model provided by the manufacturer would be achieved when the number of tests during the year reaches 300. The slope of the cost improvement curve was estimated as -0.1215, which correspond to saving of 8.08 percent per doubling of production volume.

[52] As mentioned earlier, the markup includes incremental cost components, such as potential additional packing and shipping cost, new product manuals and documentation, additional distribution costs associated with changes in merchandising, marketing, promotion, advertising, as well as additional profits for retailers, wholesalers, distributors, and even manufacturing firms, The markup used for the portable generator industry is a proxy value obtained from multiple sources, as 68 percent, or a 1.68 multiplier over manufacturing costs.

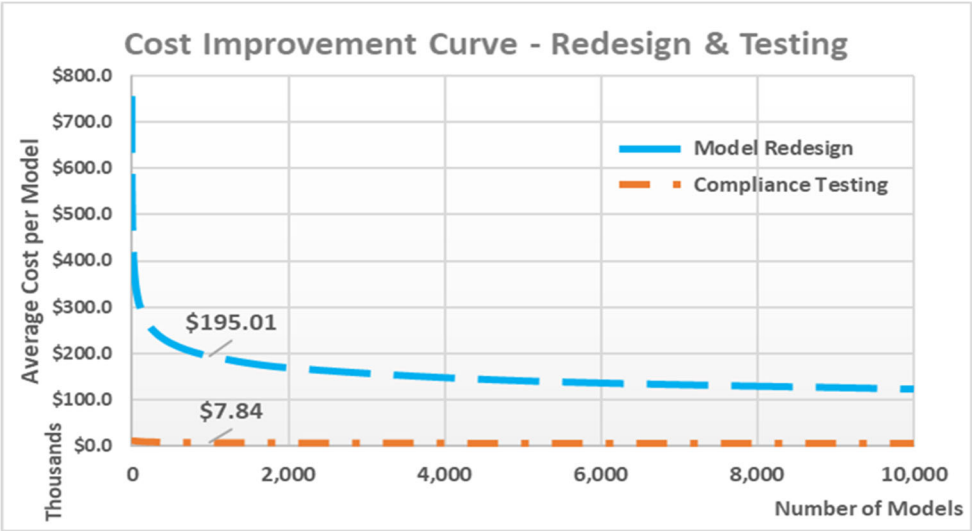

Figure 6: Average Unit Cost by Number of Model Redesign and Testing

C. CO Sensor Replacement

Consumers would incur additional costs from the draft proposed rule from having to replace CO sensors in portable generators over the life of the product. Staff reviewed similar sensor technologies to ascertain the expected life of CO sensors and found the average is 7 years. Staff then created a statistical distribution of sensor failures centered around the average expected life of the sensor,[53] along with the statistical distribution of portable generator survivals.[54] The statistical distribution of portable generator survival is tied to the statistical distribution of sensor failures. Specifically, when a portable generator fails for reasons other than from sensor failure, the CO sensor lifecycle ends as well (i.e., newly purchased portable generators that replace broken ones come with new CO sensors). Therefore, all consumer sensor replacements come from portable generators that did not fail. Staff estimated the number of sensor replacements using nested statistical distributions with a modified product population model[55] in both the baseline and draft proposed rule scenarios.

Figure 7 presents the total number of sensor-compliant portable generators in each scenario, as well as the estimated number of sensor replacements. As shown in Figure 7, the total number of sensor-compliant portable generators reaches 33.28 million by 2053 with the draft proposed rule, and only 10.12 million in the absence of the rule. Annual sensor replacements, in turn, reach 3.55 million by 2053 with the rule, and only 1.08 million without it.

[53] Staff used a statistical distribution to estimate the sensor failures. The statistical distribution calculates the total number of sensors that failed, and those that survived a number of years after installed for the first time. The distribution used was a gamma distribution with shape and scale parameters of 7 and 1, respectively, corresponding to a mean expected sensor lifespan of 7 years.

[54] This cumulative probability of survival is the inverse of the cumulative probability of failure.

[55] Modeling for the timing of CO sensor replacements has many complexities. A sensor has an expected average life of 7 years, and it is attached to a portable generator whose average expected life is 11 years. Therefore, staff had to account for individual CO sensor replacements as independent of the portable generator, and then account for replacements considering the potential for the portable generator's own failure. Therefore, staff modeled the number of sensor replacements analytically, using nested statistical distributions that account for product component failure with replacement, under the assumption that failed sensors are replaced over the life of the portable generators, and then scale down those estimates by the probability that the portable generator is still in-use.

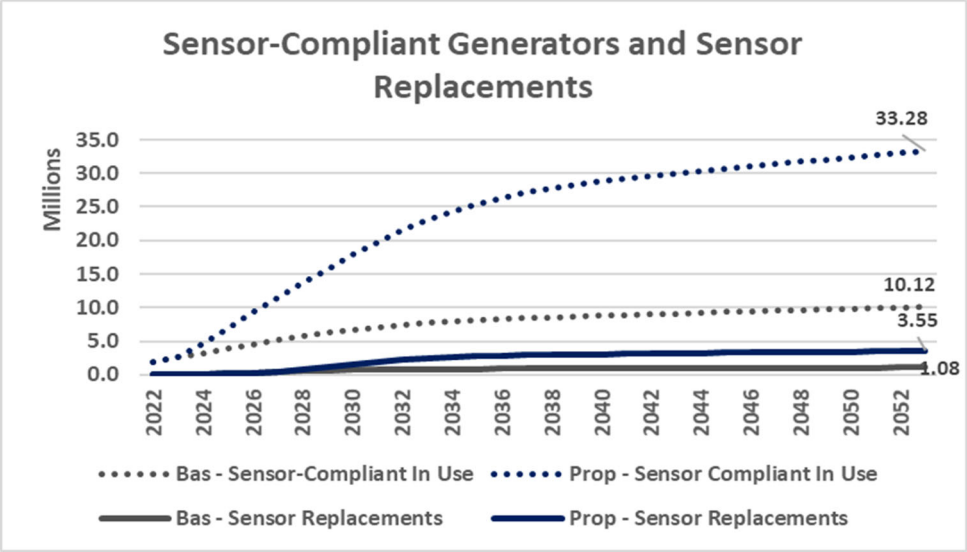

Figure 7: Sensor-Compliant Portable Generators and Sensor Replacements, 2022-2053

To estimate the cost of sensor replacements, staff also performed a review of the characteristics of compliant portable generators, including the required anti-tampering and notification mechanisms, and other features; and concluded that most manufacturers would build a large portion of the portable generators with plug-and-play CO sensors that could be replaced by the consumer without the need for a service call or a trip to a technician. Staff consequently assumed that 90 percent of all compliant portable generator would be equipped with plug-and-play CO sensors which consumers would directly replace when needed; while the other 10 percent of products would require service by a professional.

Table 6 presents the average cost of sensor replacements to the consumer, including the cost of the sensor itself, and the cost of replacement labor, when needed. The cost of a replacement sensor is based on the cost of sensors to manufacturers. The cost provided by manufacturers includes not only the sensor, but also the cost of the anti-tampering and notifications systems that go along with it. However, since manufacturers normally have access to better supplier prices, staff assumed consumers would pay on average the same amount to obtain the replacement sensor only. The overall cost of replacement sensors is also expected to decrease as manufacturers produce larger quantities, achieving economies of scale and learning cost improvements.

The cost of replacement labor is based on the average employer cost for employees' compensation in the civilian service sector of $22.59 per hour.[56] Staff assumed the consumer would be charged for half an hour of work, plus the time and out of pocket cost of the trip. The average city trip distance in the U.S. is 9.67 miles[57], and the per-mile cost of operating a vehicle is $0.62 per mile,[58] so the out of pocket cost of the trip is $5.99. The time added for the trip is

[56] Bureau of Labor Statistics, Employer Costs for Employee Compensation for civilian workers by occupational and industry group. Total Compensation for Service Employees.

[57] Bureau of Transportation Statistics. National Household Travel Survey Daily Travel Quick Facts.

[58] Bureau of Transportation Statistics. Per-Mile Cost of Owning and Operating an Automobile.

16.6 minutes,[59] so the consumer would be charged a total of $17.53 for 46.6 minutes of work, plus $5.99 for the cost of the trip itself, for a total of $24.05.[60] However, since only 10 percent of the replacements would be performed by a professional, the added cost for the average sensor replacement is only $2.41.[61] Staff assumed that there is not a significant margin for cost improvements with respect to this replacement labor, so this cost is assumed to be constant, independent of the number of sensor replacements.

Table 6: Consumer Cost for CO Sensor Replacements

Cost of Sensor Replacement to the Consumer	Percent of Sensor Replacements Impacted	High Volume	Low Volume
Cost per Replacement Sensor	100.0%	$10.00	$24.84
Cost of Replacement Labor	10.0%	$2.41	$2.41

D. Deadweight Loss

In economics, deadweight loss refers to losses to producers and consumers from a significant change in the market, such as a new regulation. For instance, a new regulation that increases manufacturing costs, reduces the quantity producers are willing to supply at any given market price. In most consumer product markets, producers are able to transfer at least part of the increased manufacturing cost to consumers through price increases. However, with the increased manufacturing costs, the price increase may not offset the increased production costs for suppliers with the highest production costs, and therefore; these suppliers may no longer participate in the market. Similarly, the increased manufacturing cost may push some consumers to delay or avoid purchases, as the new market price now may exceed what they are willing to pay for the consumer product. The losses to these producers and consumers at the margin constitute the deadweight loss.

To produce an estimate of the market-related losses to producers and consumers, staff first estimated the average increase in the manufacturing cost of portable generators. Then, staff estimated the impact of the increased manufacturing cost on the market price and the volume of

[59] The average speed of 35 miles per hour was used to estimate the time for the trip,

[60] After receiving a system notification indicating the the sensor's failure, the consumer may choose to bring the portable generator to a small engine repair shop during his/her spare time, instead of requesting a house call. In such a case, the consumer would incur a similar out-of-pocket cost for the trip, but would not have to pay the repair shop for the time spent on the road. Instead, it would incur a cost equivalent to the value of his/her spare time traveling to/from the repair facility. Multiple factors may influence the value of the customers' spare time, but it would likely be, on average, lower than the commercial value of the time spent by a technician on the road. Therefore, to produce a more conservative estimate (higher costs), staff chose to use the higher cost associated with a house call as representative of the average cost per sensor replacement.

[61] Since only ten percent of sensor replacements required a technician, ten percent of the estimated labor replacement cost of $24.01 is added to the average cost increased when all sensor replacements are considered.

portable generators. Staff then used the new equilibrium price and volume to calculate the deadweight loss for each year in the 30-year study period, as describe in the next section.

E. 30-Year Cost Analysis

This section presents the aggregate costs for each category over the 30-year study period. Staff considered a 30-year period because it provides ample time for the substitution of most noncompliant generators in consumer hands with compliant portable generators; hence, it allows for the estimation of the full cost impacts of the draft proposed rule. This timeframe also enables the analysis to account for the full impact from the initial capital investments deployed by industry in the first years following the implementation of the draft proposed rule.

1. 30-Year Manufacturing Cost - CO Emission Reduction and CO Sensors and Shutoff Capabilities

To estimate the manufacturing cost of upgrading portable generators to include CO emission reduction and CO sensor and shutoff capabilities, staff first estimated the number of units sold each year, as discussed in section II.C. Then, based on the number of units sold each year, staff estimated the average per-unit costs using the cost improvement curve discussed in section III.A. Finally, staff multiplied the number of portable generators by the average per-unit cost for each year throughout the 30-year period of analysis.

Staff estimated the cost of portable generators upgraded to be compliant under two scenarios – the baseline (without the rule) and the scenario which the rule is implemented. The baseline scenario assumes portable generator models become compliant with either UL 2201 or PGMA G300 under the current rates of compliance. In the baseline scenario, the number of compliant (with UL 2201 or PGMA G300) units still grows over 30 years, despite consistent compliance rates, because new units replace older noncompliant units.[62] The difference between the total manufacturing cost under the draft proposed rule scenario and the total cost under the baseline scenario is the net manufacturing cost of the draft proposed rule. Figure 8 presents both costs for each scenario and the difference.

[62] Staff assumed for simplicity that manufacturers do not accumulate significant inventories over time, and produce enough to cover the demand for the year.

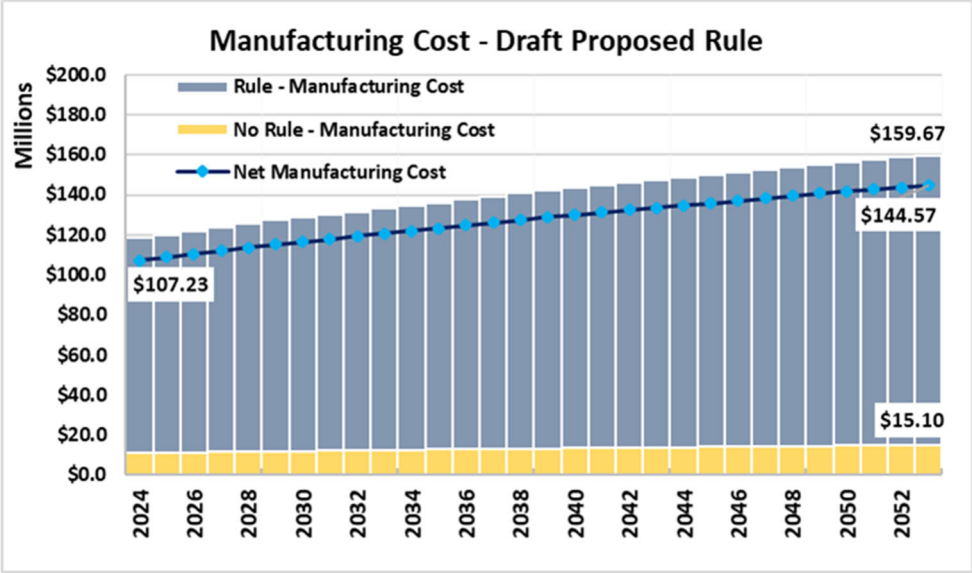

Figure 8: Net Manufacturing Cost of Upgrading Portable Generators, 2024-2053

Figure 8 shows that the cost of upgrading portable generators to be compliant with the requirements of the draft proposed rule are $118.33 million in 2024 and reached $159.67 million by 2053. In the absence of the draft proposed rule, the cost of upgrading portable generators to be compliant with either set requirements at the rates currently observed would be $11.10 million in 2024 and reach $15.10 million by 2053. The net cost of the draft proposed rule is then $107.23 million in 2024 and $144.57 million in 2053. Over 30 years, the net manufacturing costs of the rule aggregate to $3.82 billion undiscounted, $2.37 billion discounted at 3 percent, and $1.41 billion discounted at 7 percent.

2. 30-Year Model Redesign and Testing Cost

One-time conversion costs include expenses to upgrade portable generator models to include CO emission reduction and CO sensor and shutoff capabilities; and recurrent costs of model testing, which include continuous expenses of testing for compliance. Staff calculated these costs by multiplying the number of portable generator models available for sale, as well as the number of new portable generators models introduced each year, as discussed in section II.C, with the estimated average per-model cost that correspond to the number of models to be upgraded each year of the 30-year study period using the cost improvement curve discussed in section III.B.

The total cost of both model upgrade and testing are presented in Figure 9 under the draft proposed rule scenario and baseline scenario. The net cost of the draft proposed rule is the difference between these two totals.

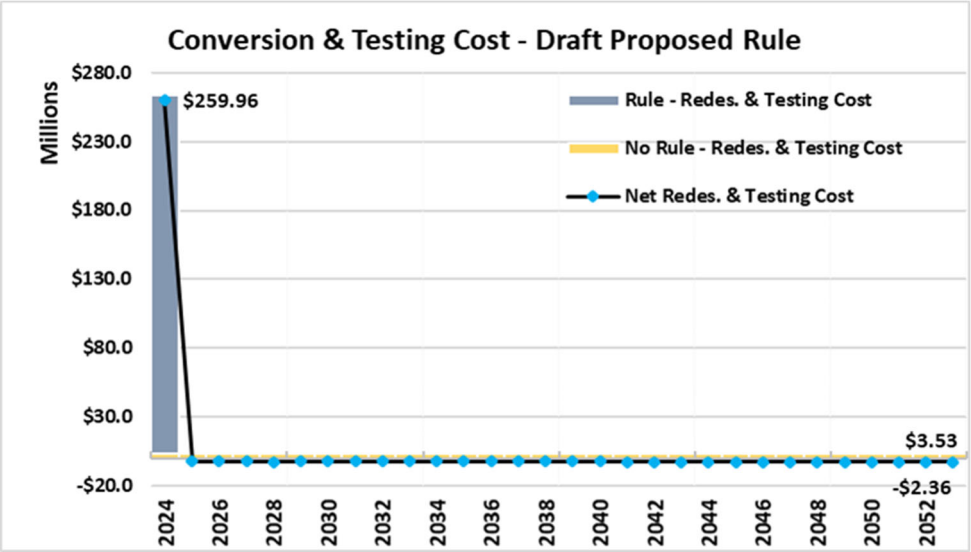

Figure 9: Model Redesign and Testing Cost for Upgrading Portable Generators, 2024-2053

Figure 9 shows that the cost of upgrading portable generator models to become compliant with the draft proposed rule are $263.46 million in 2024; in 2025 and after, manufacturers continue testing new models at an annual cost of $1.16 million to $1.17 million. In the absence of the draft proposed rule, there is no singular push to upgrade all models at the same time; instead it is expected that industry continues to introduce new models compliant with either voluntary standard at rates similar to those observed today, which would create an annual cost between $3.50 million and $3.53 million for model redesigned and model testing. The net cost is then $259.96 million in 2024 and approximately $2.34 million to $2.36 million in 2025 and after. Over 30 years, the net redesign and testing costs aggregate to $191.74 million undiscounted, $202.51 million discounted at 3 percent, and $201.86 million discounted at 7 percent.

3. 30-Year CO Sensor Replacement Cost

In section III.C, staff estimated the per-unit sensor replacement cost to be between $12.41 and $27.24; with the average cost dependent on where firms are along the cost improvement curve in a given year. In section III.C, staff also describes the estimation of the number of CO sensor replacements throughout the 30-year study period. Staff estimated the total cost of sensor replacements by multiplying the number of sensor replacements performed each year with the average sensor replacement cost along the cost improvement curve.

Staff estimated the cost of sensor replacements under the baseline and with the draft proposed rule scenarios. The total cost of replacements under each of these two scenarios is presented in Figure 10. The net cost is the difference between the two scenarios.

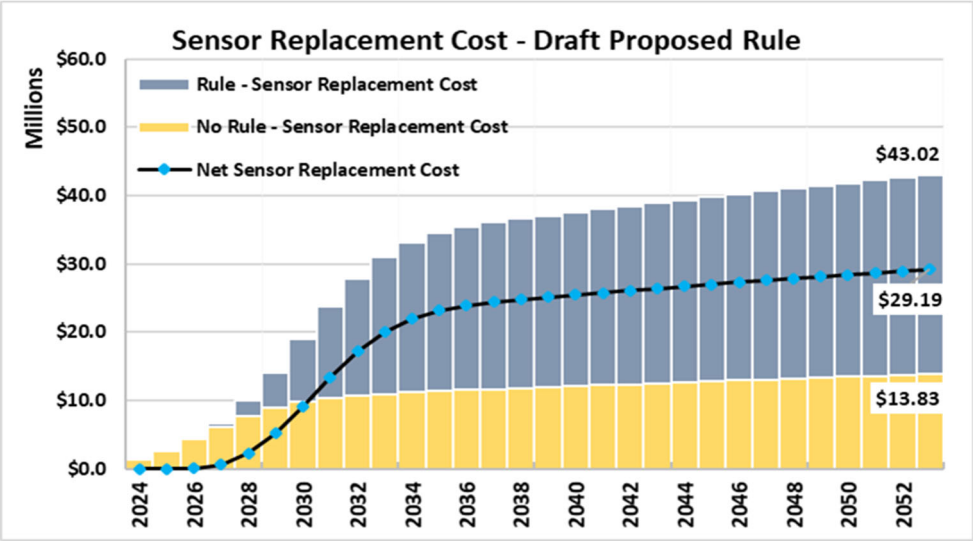

Figure 10: Sensor Replacement Cost by Consumers, 2024-2053

The net cost of sensor replacements is essentially zero in the first year of the rule (2024), as very few replacements are forecasted to occur. In the last year of the rule (2053), the total cost of sensor replacement reaches $43.02 million in the draft proposed rule scenario. In 2053, the cost of sensor replacements without the rule would be close to $13.83 million. The net cost of sensor replacements is then $29.19 million in 2053. Over 30 years, consumers would spend in sensor replacements a net of $594.94 million undiscounted, $331.15 million discounted at 3 percent, and $164.99 million discounted at 7 percent.

4. Deadweight Loss

To estimate deadweight loss in each year of the 30-year study period, staff first estimated average long-term incremental cost per portable generator, resulting from all modifications required by the draft proposed rule.[63] The average incremental cost was offset by the incremental costs expected in the absence of the draft proposed rule because of the continuous introduction of portable generators compliant with either voluntary standard.

[63] The average long-term manufacturing cost include the cost of labor and materials to produce portable generators compliant with the emissions and sensor/shutoff requirements of the draft proposed rule, the cost of upgrading portable generator models to be compliant with the emission and sensor/shutoff requirements, as well as the cost of testing the upgraded models for compliance with these requirements, In order to produce conservative cost estimates, staff also included in the manufacturing cost, a 1.68 markup factor that is expected to account for cost not directly accounted for in the analysis, such as potential additional packing and shipping costs, new product manuals and documentation, additional distribution costs associated with changes in merchandising, marketing, promotion, advertising, etc.; and, most prominently, additional profits for retailers, wholesalers, distributors, and even manufacturing firms.

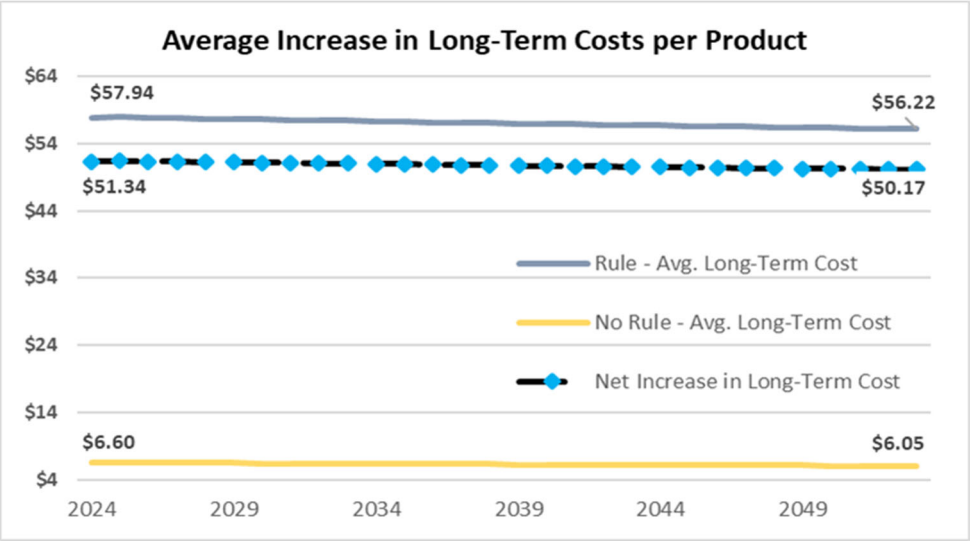

Figure 11: Incremental Net Model Redesign and Testing Cost for Upgrading Portable Generators, 2024-2053

Figure 11 displays the increase in cost per portable generator from the draft proposed rule and the increase in cost in the absence of the rule due to the introduction of compliant portable generators. The dashed line is the net incremental cost per product between the two scenarios. In 2024, the requirements of the draft proposed rule would increase the cost per portable generator by $57.94, this change in cost decreases overtime due to cost improvements associated with economies of scale and learning, reaching $56.22 in 2053. Similarly, without the draft proposed rule, the average long-term cost of portable generators would increase by $6.60; a declining cost trend makes the average long-term cost reach $6.05 in 2053. The net cost increase associated with the implementation of the draft proposed rule is $51.34 in 2024 and $50.17 in 2053.

As mentioned earlier, the average long-term increase in cost includes a factor that augments manufacturing cost by a 68 percent producer to retailer markup[64] to account for the impact of profits and other cost increases along the supply chain. Including the markup factor augments the average long-term cost of the rule to approximately $57.94 in 2024, and $56.22 in 2053. The impact of the draft proposed rule's cost increases on the average price of portable generators is relatively small, representing approximately a 3.32 percent increase in average prices.[65] Consequently, the change in market volume is also relatively small, with an average reduction in volumes of 1.34 percent, as shown in Figure 12.

[64] The effective market impact is likely to include a distribution markup to cover costs along the supply chain. The 68 percent markup comes from Goldberg 1995 and others.

[65] The price impact is estimated with the formula $\Delta P = \Delta C_p \left(\frac{\varepsilon_s}{\varepsilon_s - \varepsilon_d}\right)$, which in this specific context means the change in price equals the change in long-term average cost (including a markup), times the ratio of the elasticity of supply to the difference between elasticity of supply and demand. Using the average change in production cost of $51.34 in 2024 (no additional markup, since the distribution markup was internalized into manufacturing costs), ΔCp equals $51.34. Staff is not aware of specific elasticity estimates for portable generators, but given the nature of the product, demand is likely inelastic. The elasticity of supply and demand used as proxies come from energy markets, and were developed by the Bureau of Ocean Energy Management, and the U.S. Energy Information Administration. Elasticity of supply and demand from those sources are 0.74 and -0.40, respectively. Hence $\Delta P = \$51.34 \left(\frac{0.74}{0.74-(-0.40)}\right) = \$33.25$. At an average price before the rule of $1,000.41, this represents roughly a 3.32 percent increase.

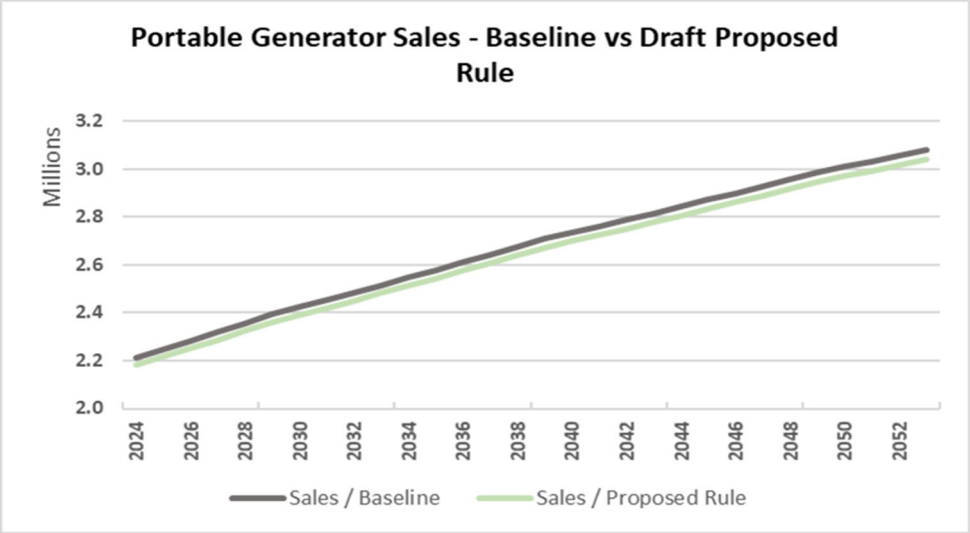

Figure 12: Portable Generator Sales – Baseline vs Draft Proposed Rule, 2024-2053

The change in the cost of portable generators with the draft proposed rule causes a small reduction in the total number of portable generators sold each year, which impacts the number of portable generators in use. In terms of products in use; however, the largest impact of the draft proposed rule is in the proportion of products compliant and noncompliant, as shown in Figure 13.

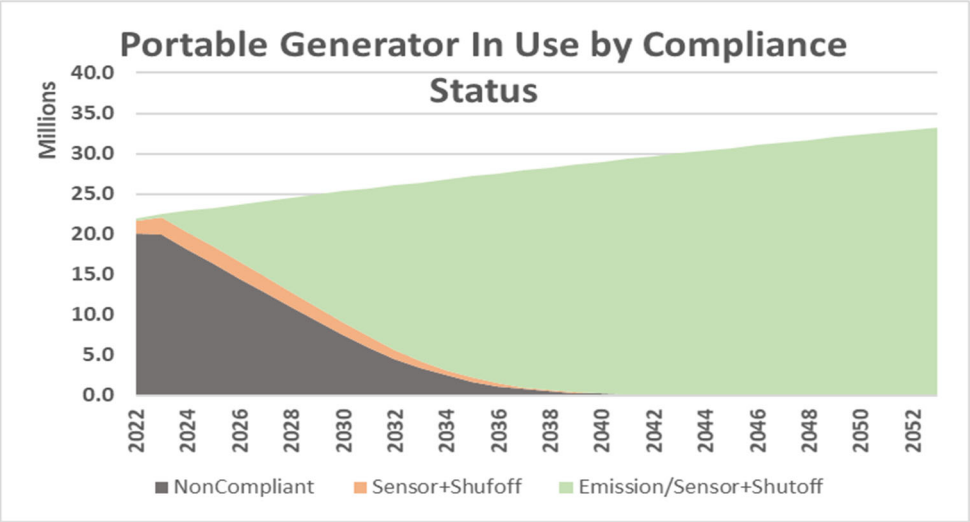

Figure 13: Reduction in Portable Generator Sales due to the Rule, 2022-2053

Staff estimated deadweight loss by multiplying the change in the volume of sales and the change in long-term production cost, including the supply chain markup, and then dividing by two.[66] The first year of the rule (2024), undiscounted deadweight loss nears $0.76 million, and reaches $1.01 million in the last year of the rule (2053). Over 30 years, these costs aggregate to

[66] For instance, in 2024 deadweight loss is estimated as the change in volume times the increased production cost of $51.34, divided by 2. The change in sales volume in 2024 is 29,563, meaning the sales without the rule are reduced by this number of portable generators with the implementation of the rule. Deadweight loss is then: 29,563x $51.34/ 2 = $758,881 (slight mismatch due to rounding). Consumer surplus losses represent roughly 64.8 percent of the total deadweight loss, while producer surplus represents 35.2 percent.

$26.91 million undiscounted, $16.71 million discounted at 3 percent, and $9.93 million discounted at 7 percent.

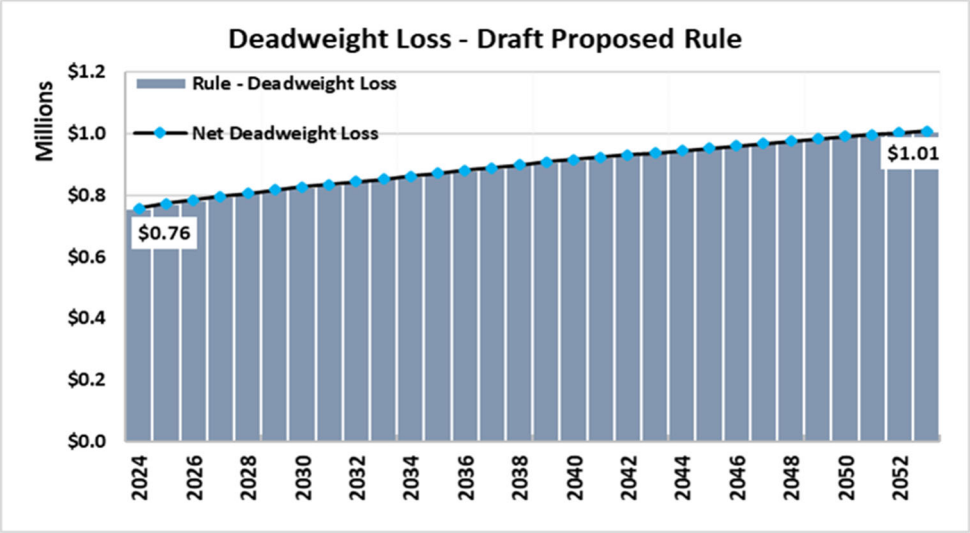

Figure 14: Deadweight Loss due to the Rule, 2024-2053

5. 30-Year Total Cost of the Draft Proposed Rule

Staff added up all cost categories to determine the total cost of the draft proposed rule over the 30-year study period, as shown in Figure 15.

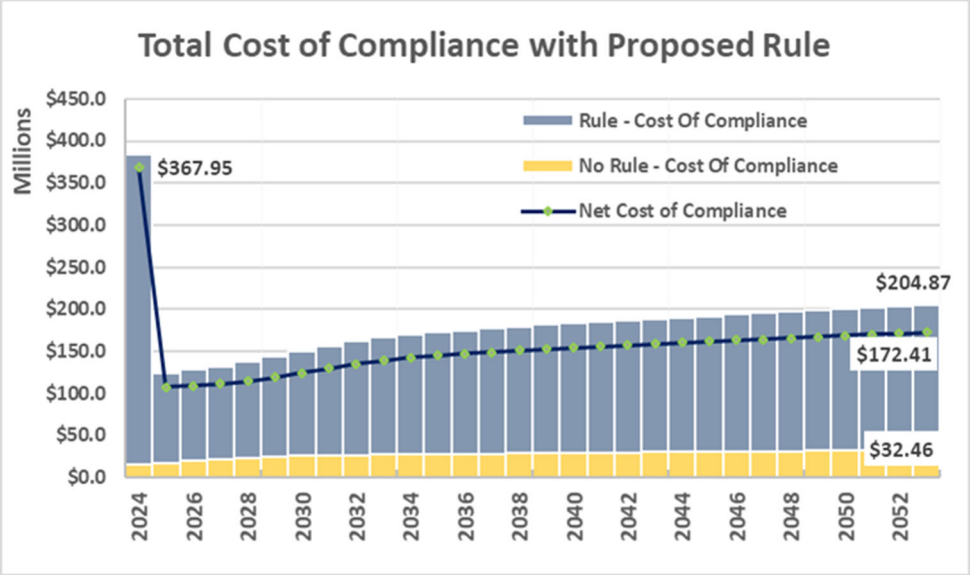

Figure 15: Total Costs over the 30-Year Study Period

Over 30 years, the net cost of implementing the draft proposed rule add up to $4.63 billion undiscounted, $2.92 billion discounted at 3 percent, and $1.78 billion discounted at 7 percent.

6. Annualized and Per Unit Cost of the Draft Proposed Rule

This section converts the aggregate costs over the 30-year study period into annualized and per-unit outputs. An annualized output converts the aggregate costs over 30 years into a

consistent annual amount while considering the time value of money. This metric is helpful when comparing the costs among different rules or policy alternatives that may have different timelines; or those that have similar timelines but costs for one are front-loaded while the other's maybe backloaded.[67] A per-product metric expresses the costs from the rule in one unit of product. This metric is helpful when assessing the impact in marginal terms; for example, comparing costs to an increase in retail price. Staff presents both these metrics to convey a holistic perspective of the impact from this draft proposed rule.

Table 7 summarizes the net cost of the draft proposed rule in annualized terms:

Table 7: Annualized Cost of the Draft Proposed Rule

Cost Categories	Annualized Cost ($M)		
	Undiscounted	3% Discount	7% Discount
Manufacturing Cost	$127.31	$120.86	$113.20
Model Redesign and Testing	$6.39	$10.33	$16.27
CO Sensor Replacement	$19.83	$16.90	$13.30
Deadweight Loss	$0.90	$0.85	$0.80
Total Cost	**$154.43**	**$148.94**	**$143.56**

Table 8 below splits the annualized cost of the draft proposed rule discounted at 3 percent between producers and consumers. The table shows that consumers are expected to pay the largest share of the cost for the additional level of safety provided by the portable generators updated to comply with the rule.

[67] The timing of costs along the period of study affects the present value of costs when considering the time value of money. Costs incurred several years into the future are discounted more heavily than costs realized in the short-term.

Table 8: Annualized Cost to Consumers and Producers Discounted at 3%

Cost Categories	Annualized Cost at 3% Discount Rate ($M)		
	Consumers	Producers	Total
Manufacturing Cost	-	$120.86	$120.86
Model Redesign and Testing	-	$10.33	$10.33
CO Sensor Replacement	$16.90	-	$16.90
Deadweight Loss	$0.55	$0.30	$0.85
Consumer Surplus	$0.55		-
Producer Surplus		$0.30	-
Transfer from Consumers through Price Increases[68]	$82.30	($82.30)	-
Total Cost	**$99.75**	**$49.20**	**$148.94**

Table 9 summarizes the net cost of the draft proposed rule in per unit[69] terms:

Table 9: Per Unit Cost of the Draft Proposed Rule

Cost Per Product	Cost per Product ($)		
	Undiscounted	3% Discount	7% Discount
Manufacturing Cost	$50.83	$31.53	$18.69
Model Redesign and Testing	$2.55	$2.69	$2.69
CO Sensor Replacement	$7.92	$4.41	$2.20
Deadweight Loss	$0.36	$0.22	$0.13
Total Cost	**$61.66**	**$38.85**	**$23.71**

IV. Preliminary Regulatory Analysis: Benefits Assessment

Staff conducted the preliminary regulatory analysis from a societal perspective that considers significant costs and health outcomes (Gold et al., 1996; Haddix, Teutsch, and Corso, 2003; Neumann et al, 2016). Staff from the Directorate for Epidemiology (EP) estimated the number of

[68] The transfer from consumers to producer was estimated by multiplying the change in the average price per portable generator times the number of generators sold after the implementation of the draft proposed rule.

[69] Staff calculates per-unit metrics by dividing the 30-year total by the number of products modified with the proposed draft rule minus those made compliant without the rule.

injuries from casualties reported through the National Electronic Injury Surveillance System (NEISS) - a national probability sample of U.S. hospital emergency departments (ED) - and counted the number of deaths entered in the Consumer Product Safety Risk Management System (CPSRMS) - a database of consumer incident reports.

In addition to these two databases, staff used estimates generated by the CPSC's Injury Cost Model (ICM). The ICM uses data from NEISS to generate national estimates of the number of ED-treated injuries and hospital admissions. Beyond injuries initially treated in EDs and through hospital admissions, many product-related injuries are treated in other medical settings, such as physicians' offices, clinics, and ambulatory surgery centers. Some injuries also result in direct hospital admissions, bypassing the hospital ED entirely. The ICM also estimates the number of portable generator-related injuries treated outside of hospital EDs using empirical relations between the characteristics of injuries (diagnosis and body part) and victims (age and sex) initially treated in hospital EDs and the characteristics of those initially treated in other settings.[70]

Staff then used death counts and the ICM national estimates of the number of injuries to forecast the number of expected deaths and injuries for a 30-year study period. To produce a forecast, staff assumed the incident rates by type of injury per million portable generators would remain at the same levels experienced during the period 2004 through 2021. Staff then used the expected effectiveness of the draft proposed rule in preventing deaths and injuries to estimate the number of prevented fatalities and injuries; which were then monetized using the VSL for deaths; and ICM cost estimates for injuries.[71] Staff then converted the aggregate benefits over the 30-year study period into annualized[72] and per unit outputs.[73]

A. Deaths and Injuries from 2004 through 2021 and Their Societal Costs

Staff identified at least 1,332 deaths from portable generator-related CO poisonings that occurred from 2004 through 2021 using incidents reported in the CPSRMS database as of May 10, 2022. To estimate the societal costs of deaths, staff uses the VSL. VSL is an estimate used

[70] The ICM estimate of injuries treated outside of hospitals or hospital EDs (e.g., in doctors' offices, clinics) is based on data from the Medical Expenditure Panel Survey (MEPS). The MEPS is a nationally representative survey of the civilian, non-institutionalized population that quantifies individuals' use of health services and corresponding medical expenditures. To project the number of direct hospital admissions that bypass hospital EDs, the ICM uses data from the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS). HCUP is a family of healthcare databases and related software tools and products developed through a federal-state-industry partnership and sponsored by AHRQ. The HCUP-NIS provides information, annually, on approximately 3 million to 4 million inpatient stays from about 1,000 hospitals. A detailed discussion of the methodology used by the ICM to estimate medically treated injuries outside of hospital EDs is given in Lawrence et al. (2018).

[71] The ICM uses NEISS estimates of emergency department-treated injuries and imputes estimates of injuries treated in other medical settings using the empirical relationships between injuries treated in emergency departments and these other settings. The societal cost estimates include the cost of medical treatment, lost worktime, and intangible pain and suffering costs; the intangible pain and suffering costs account for about three quarters of this total. See Lawrence et al., 2018 for additional information.

[72] As mentioned earlier for costs, an annualized output converts the aggregate benefits over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the benefits among different rules or policy alternatives that may have different timelines; or those that have similar timelines but benefits for one are front-loaded while the other's benefits have a latent effect. The timing of benefits along the period of study affects the present value of benefits when considering the time value of money. Benefits realized several years into the future are discounted more heavily than benefits realized in the short-term.

[73] A per-unit metric expresses the benefits from the rule in one unit of product. This metric is helpful when assessing the impact in marginal terms; for example, comparing benefits to an increase in retail price or marginal increase in cost of production per-unit.

in benefit-cost analysis that places a value on reductions in the likelihood of premature deaths (OMB, 2003). The VSL does not place a value on individual lives, but rather, it represents an extrapolated "willingness-to-pay" estimate, based on the rate at which individuals trade money for small changes in mortality risk (OMB, 2003). The willingness-to-pay method attempts to measure how much individuals are willing to pay for a small reduction in their own mortality risks, or how much additional compensation they would require to accept slightly higher mortality risks. For this analysis, staff applied estimates of the VSL developed by the U.S. Department of Heatlh and Human Services (HHS). The HHS estimate of the VSL, when adjusted for inflation, is $11.6 million in 2021 dollars.[74] [75]

Staff retrieved injuries reported by hospital EDs through NEISS, and used these NEISS incidents with the ICM to extrapolate and generate national estimates of injuries from the use of portable generators in EDs and other settings. The ICM estimated the aggregate number of nonfatal injuries using portable generator-related records from 2004 through 2021.

Staff estimated the societal costs of nonfatal injuries using the ICM. Societal cost components include medical costs, work losses, and the intangible costs associated with pain and suffering (Lawrence et al., 2018).

Medical costs include three categories of expenditures: (1) medical and hospital costs associated with treating the injured victim during the initial recovery period and in the long run, including the costs associated with corrective surgery, the treatment of chronic injuries, and rehabilitation services; (2) ancillary costs, such as costs for prescriptions, medical equipment, and ambulance transport; and (3) costs of health insurance claims processing. The ICM derives cost estimates for these expenditure categories from several national and state databases, including the Medical Expenditure Panel Survey (MEPS), the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), the Nationwide Emergency Department Sample (NEDS), the National Nursing Home Survey (NNHS), MarketScan® claims data, and a variety of other federal, state, and private databases.

Work loss estimates include: (1) the forgone earnings of the victim, including lost wage work and household work; (2) the forgone earnings of parents and visitors, including lost wage work and household work; (3) imputed long-term work losses of the victim that would be associated with permanent impairment; and (4) employer productivity losses, such as the costs incurred when employers spend time rearranging schedules or training replacement workers. The ICM bases these estimates on information from the MEPS, the Detailed Claim Information (a workers' compensation database) maintained by the National Council on Compensation

[74] In 2013, HHS estimated the value of a statistical life at $9.0 million based on a study conducted by Robinson and Hammit (2016). CPSC staff adjusted this estimate using the same procedure HHS uses to update the value annually. First, CPSC adjusted the estimate for inflation to the end of 2021 using the annual averages of the Consumer Price Index for All Urban Consumers (CPI-U) generated by the Bureau of Labor Statistics. Then, CPSC staff updated the estimate for changes in real income using the change in the Median Usual Weekly Earnings (MUWE) for All Occupations along with the average income elasticity (assumed to be 1). The estimate was then rounded to the nearest hundred thousand. The adjustment is as follows: $9.0 m x (270.970 ÷ 232.957) x (368 ÷ 333) ^1 = $11.569 m, which is then rounded to $11.6 million (values may differ slightly due to rounding). The VSL for future years (after 2021) is updated by changes in real income, which the Congressional Budget Office (CBO) estimates will grow at a rate of 0.8 percent per year.

[75] Research indicates that the VSL for children is higher than that of adults, as parents have been observed paying more to reduce the mortality risk of their children than what they pay to reduce their own mortality risks. A higher willingness to pay for risk reductions of their children's lives implies a higher VSL for children, which would indicate the benefit estimates developed in this assessment may be undervalued.

Insurance, the National Health Interview Survey, the U.S. Bureau of Labor Statistics, and other sources.

The intangible costs of injury reflect the physical and emotional trauma of injury, as well as the mental anguish of victims and caregivers. Intangible costs are difficult to quantify because they do not represent products or resources traded in the marketplace. Nevertheless, they typically represent the largest component of injury cost, and need to be accounted for in any benefit-cost analysis involving health outcomes (Rice et al., 1989; Haddix, Teutsch, and Corso, 2003; Cohen and Miller, 2003; Neumann et al, 2016). The ICM develops a monetary estimate of these intangible costs from jury awards for pain and suffering. Although these awards can vary widely on a case-by-case basis, studies have shown these are systematically related to several factors, including economic losses, the type and severity of injury, and the age of the victim (Viscusi, 1988; Rodgers, 1993; Cohen and Miller, 2003). The ICM derives these estimates from a regression analysis of jury awards in nonfatal product liability cases involving consumer products compiled by Jury Verdicts Research, Inc.

The following table summarizes the number of observed deaths and injuries from 2004 through 2021, the annual average of deaths and injuries by severity, and the societal cost for each:

Table 10: Number of Deaths / Injuries and Social Costs

Place of Treatment	National Estimate	Annual Average	Societal Cost per Unit
Doctor / Clinic	52,782	2,932	$18,034
Emergency Department	17,569	976	$21,687
Hospital Admission	7,308	406	$384,789
Deaths	1,332	74	$11,600,000

B. Effectiveness of the CO Hazard Mitigation Requirements in the Voluntary Standards for Portable Generators

Staff evaluated the effectiveness of the CO hazard mitigation requirements in the voluntary standards by developing a simulation experiment in coordination with NIST.[76] The simulations

[76] The effectiveness assessment consisted of simulations of a subset of fatal incident data from CPSC's databases using an indoor air quality (IAQ) modeling program called CONTAM. CONTAM simulated a 24-hour period during which a noncompliant generator, referred to as a "baseline generator," emitted CO at a specified rate, representing a noncompliant generator, at a specified location inside or near a house, for a specified number of hours, which represented the generator's run time associated with that CO emission rate on a full tank of fuel. CONTAM simulated the accumulation and transport of CO throughout the house while the generator was emitting CO, and the continued transport of CO for the remainder of the 24-hour period after the generator ran out of fuel. For each of the voluntary standard-compliant generators, CONTAM also simulated a 24-hour period that started with the generator operating in the same location inside the house as the baseline generator, emitting CO at a specified rate, representative of a voluntary standard-compliant generator. However, if the CO concentration in that location reached the voluntary standard's criteria for shutting off the generator, the CO emission stopped. The simulation then continued in one of a variety of ways for the remainder of the 24-hour period, i.e., with the generator either not restarted, or restarted 10 minutes later in the same location, or in a new location, that was either indoors or outdoors. If indoors and it stopped

replicated 511 fatalities in CPSC's databases. Staff's analysis found that under simulated conditions, generators compliant with the PGMA G300 standard's shutoff requirements would have averted nearly 87 percent of deaths that occurred with noncompliant generators, with 69 deaths, 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released. Staff's analysis found that under simulated conditions, generators compliant with the UL 2201 standard's CO emission rate and shutoff requirements would avert nearly 100 percent of the deaths, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. Staff used the result of these simulations to estimate the rate of effectiveness of each standard in reducing death or injuries, or in degrading these deaths and injuries into less consequential injuries. Table 11 below presents the results of staff's analysis.

Table 11: Simulations to Measure Effectiveness of Voluntary Standards

Outcome for Operators and Collateral Occupants	Type of Portable Generators		
	Baseline (noncompliant)	PGMA G300	UL 2201
Fatality	511	69	0.04
Survivors who are hospitalized or transferred to specialized treatment center	- -	54	3
Survivors who seek medical treatment and are treated and released	- -	88	24
Survivors who are likely not symptomatic and not seeking medical treatment	- -	300	484

Staff used the efficacy rates in Table 11 to generate Table 12, which presents the rates at which deaths that occurred with noncompliant portable generators degrade into injuries of different severities – based on where they are treated – for each of the two voluntary standards. Staff split the rate corresponding to survivors who seek medical treatment and are released into two categories: survivors treated at EDs and those treated at doctor/clinic's offices. Staff assumes the proportions between those two injury categories stays the same as estimated by the ICM;

again, it was restarted a second time outdoors. In every simulation in which the generator was restarted, the voluntary standard-compliant generator operated until the full fuel tank was empty, just as the noncompliant generator operated. Every simulation yielded CO concentrations in each room of the house as a function of time over the 24-hour analysis interval. These concentrations were then used to calculate carboxyhemoglobin (COHb) levels for the house's theoretical occupants. The COHb level serves as a useful measure of expected CO poisoning severity. Comparing the occupants' health effects from the simulation of a baseline generator to a voluntary standard-compliant generator provides staff's assessment of the benefits offered by the compliant generators for deaths averted and level of injury, if any, the survivors sustained. Staff completed approximately 140,000 simulations for 37 different house models and three detached garages, with various generator locations and generator sizes in 28 different weather conditions. *CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*, February 16, 2022. https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in www.regulations.gov)

that is, approximately 1 ED for 3 doctor/clinic's office visits (24.97 percent of the total to be more exact).

Table 12: Rates of Fatality Degradation into Injuries By Severity for Each Voluntary Standards

VS Improvement on Fatalities	G300	UL 2201
Fatality Persistence	**13.40%**	**0.01%**
Fatality Degraded to Hospitalization	10.61%	0.63%
Fatality Degraded to ED Visit	4.26%	1.16%
Fatality Degraded to Doctor/Clinic Visit	12.79%	3.48%
Fatality Degraded to Non-Injury	58.94%	94.73%
Fatalities Averted	**86.60%**	**99.99%**

Staff then assumed that the rates at which deaths degrade into less consequential injuries also apply to other injuries that degrade into less severe ones. Staff kept the percent of degradation the same as deaths for each severity of injury, except for the rate for the lowest level (based on upon that severity) which staff adjusts as the remaining available percentage. For example, staff assumed that hospitalizations would also have a persistence rate of 13.4 percent with a G300 portable generator, and that they would degrade one level (into ED visits) at 10.61 percent, degrade two levels (into doctor/clinic visit) at 4.26 percent, and finally degrade three levels (into noninjuries) at 71.73 percent.[77] This same logic applies for other injury levels, as presented in Table 13 and Table 14 for PGMA G300 and UL 2201, respectively.

Table 13: Rates of Degradation by Severity of Injury for PGMA G300

G300 - Averted or Degraded	Death	Hospital Admission	Emergency Department	Doctor / Clinic
Persistence	**13.40%**	**13.40%**	**13.40%**	**13.40%**
Degraded One Level	10.61%	10.61%	10.61%	86.60%
Degraded Two Levels	4.26%	4.26%	75.99%	
Degraded Three Levels	12.79%	71.73%		
Degraded Four Levels	58.94%			
Averted	**86.60%**	**86.60%**	**86.60%**	**86.60%**

[77] 71.73% = 100% - 13.40% persistence – 10.61% degraded one level – 4.26% degraded two levels.

Table 14: Rates of Degradation by Severity of Injury for UL 2201

UL 2201 - Averted or Degraded	Death	Hospital Admission	Emergency Department	Doctor / Clinic
Persistence	**0.01%**	**0.01%**	**0.01%**	**0.01%**
Degraded One Level	0.63%	0.63%	0.63%	99.99%
Degraded Two Levels	1.16%	1.16%	99.36%	
Degraded Three Levels	3.48%	98.21%		
Degraded Four Levels	94.73%			
Averted	**99.99%**	**99.99%**	**99.99%**	**99.99%**

Staff multiplied the number of average annual deaths and injuries presented in Table 10 by the rates presented in the two tables above to estimate the number of annual deaths and injuries that would have occurred per year if all portable generators that were used when those injuries occurred were compliant with one of these standards. The results are presented in Table 15.

Table 15: Estimated Efficacy Rate by Severity Under Each Voluntary Standard

Severity of Injury	Annual Average	G300	G300 Efficacy Rate	UL 2201	UL 2201 Efficacy Rate
Deaths	74	10	86.60%	0	100.0%
Hospital Admission	406	62	84.67%	0	99.9%
Emergency Department	976	177	81.86%	3	99.6%
Doctor / Clinic	2,932	523	82.16%	14	99.5%
Non-Injury		3,616		4,371	
Total	4,388	4,388		4,388	

Table 15 indicates that if all portable generators would have been compliant with voluntary standard G300 during the period 2004 through 2021, out of the 4,388 average annual injuries that occurred with noncompliant generator; 3,616 injuries would have been prevented. While 772 deaths and injuries would have still occurred, the number of casualties of each level of severity would have decreased between 81.86 and 86.60 percent. In the case of UL 2201, the improvements are even more significant. Out of the original 4,388 average annual injuries and deaths, 4,371 would not have happened at all if the generators would have been compliant with UL 2201. Only 17 injuries would have occurred, 3 ED and 14 doctor/clinic's office visits.

Staff uses the efficacy rates presented in Table 15 to estimate the prospective death and injury rates per million portable generators compliant with G300 and UL 2201. One caveat for staff's approach to generating Table 15 is the assumption that prospective injuries would occur in similar scenarios as those simulated for the 511 deaths. However, the hazard pattern of available NEISS injuries is largely unknown because of records with minimal narratives given their sourcing from medical treatment documentation.

Only 2 percent (8 of the 511 deaths) simulated for the effectiveness analysis involved a generator running only outside; however, 6 percent (79 of 1332 deaths) of the deaths in the 18-year period occurred with the generator operating outside (see TAB A in this briefing package); therefore, this scenario is underrepresented in the simulations upon which the injury estimates are based. Furthermore, given the reported deaths that occurred with the generator operating outside, it is reasonable to assume that at least some injuries also have occurred in this scenario. Staff recently conducted a case study that demonstrates this is not a rare occurrence. See TAB D in this briefing package. The case study involves a rash of incidents of CO exposures inside homes that were caused by portable generators operating outdoors in the greater New Orleans area, following widespread power outages caused by Hurricane Ida in the fall of 2021. Since G300 does not require a CO emission rate reduction, a G300-compliant generator running outside the home or any other occupiable structure that does not shut off presents the same risk of CO poisoning as a noncompliant generator.[78] Therefore, the effectiveness rate of G300 compliant generators shown in Table 15 may overstate the effectiveness of the standard in reducing injuries, which means the injuries from G300-compliant generators may exceed the estimates presented in this report.

Staff requests information regarding CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors.

C. Future Deaths Related to Portable Generators and Societal Savings from the Draft Proposed Rule

To forecast deaths into the future, staff used death rates per million portable generators along with its forecast of portable generators in use throughout the study period. Staff assumed the death rate for noncompliant generators would remain relatively stable, at the average rate observed between 2004 through 2021. First, the average number of portable generators in use was estimated for the base period of 2004 through 2021,[79] as well as the average annual number of deaths[80] that occurred during the period. Staff divided the average number of deaths by the average number of in-use portable generators to calculate the rate of annual deaths.

[78] The shutoff systems required by G300 and UL 2201 are expected to perform indoors but when the generator is operated outdoors, weather conditions, the direction of the generator exhaust, and other situational factors may lower the level of CO concentration near the generator and not actuate the shutoff system. A 3-fatality incident is known to have occurred with a G300-compliant generator - in the same series of Hurricane Ida incidents - which provides additional support for this argument. (See document ID number CPSC-2006-0057-0110 in www.regulations.gov)

[79] As discussed in section II.C, staff estimated the number of portable generators in use using a product population model that combines historic sales with a statistical distribution of portable generator failure rates centered on the average product lifespan.

[80] See TAB A, section II.C.

Then staff multiplied the rate of annual deaths by a million to produce the rate per million generators of 4.0342 for noncompliant generators.[81]

Staff also estimated death rates for portable generators compliant with the emission reduction and sensor/shutoff features (UL 2201); as well as for portable generators compliant with the sensor/shutoff features only (PGMA G300). Staff calculated the rate per million for portable generators compliant with one of the standards by multiplying the noncompliant rate per million by the complement of the death efficacy rate of the corresponding standard in Table 15. For instance, the rate per million for G300 is 0.5406.[82] [83]

Table 16: Death Rate per Million Generators by Generator Compliance

	Death Rate per Million Portable Generators	Efficacy Rate
Noncompliant Generator	4.0342	0.00%
G300 Compliant Generator	0.5406	86.60%
UL 2201 Compliant Generator	0.0003	99.99%

The overall efficacy rate of the draft proposed rule in any year during the period of analysis depends on the combination of portable generators that are noncompliant and compliant with the rule (UL 2201 for the emissions and shutoff/sensor requirements). Staff estimated the weighted annual efficacy rate under both scenarios – the scenario with implementation of the draft proposed rule, and the baseline scenario (which has no draft proposed rule but with some portable generators compliant with G300 and UL 2201) – by multiplying the millions of portable generators in use of each type by the corresponding rate per million. The effective annual rates per million portable generators are shown in Figure 16 under both scenarios. The base rate for noncompliant generators is also shown.

[81] 74 average annual deaths (2004-2021) ÷ 18.34 million portable generators in use each year (2004-2021) × 1 million = 4.0342

[82] The rate per million PGMA G300 portable generators can be estimated as: 4.0342 × (1 – 0.8660) = 0.5406.

[83] The rate per million UL 2201 portable generators can be estimated as: 4.0342 × (1 – 0.9999) = 0.0003.

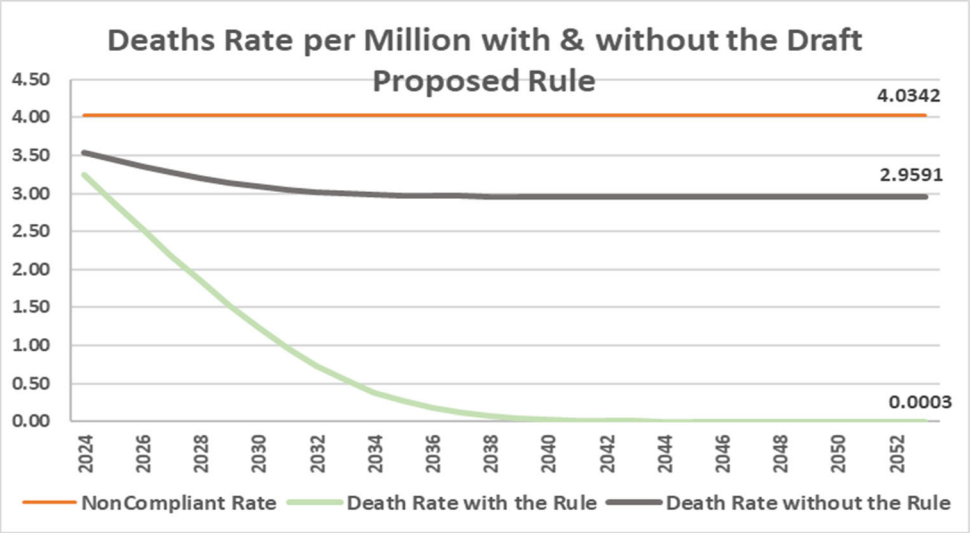

Figure 16: Death Rate per Million for Noncompliant and Compliant Generators, 2024-2053

The number of portable generators in use by compliance status is multiplied by the rates per million to calculate the number of deaths under each scenario, as shown in Figure 17. Staff calculates the total number of deaths under two scenarios. With the implementation of the draft proposed rule, the number of annual deaths would reach zero by 2041. In the absence of the draft proposed rule and with the levels of voluntary standard compliance at current rates, there would be 100 deaths related to CO poisoning from portable generators in 2053.[84]

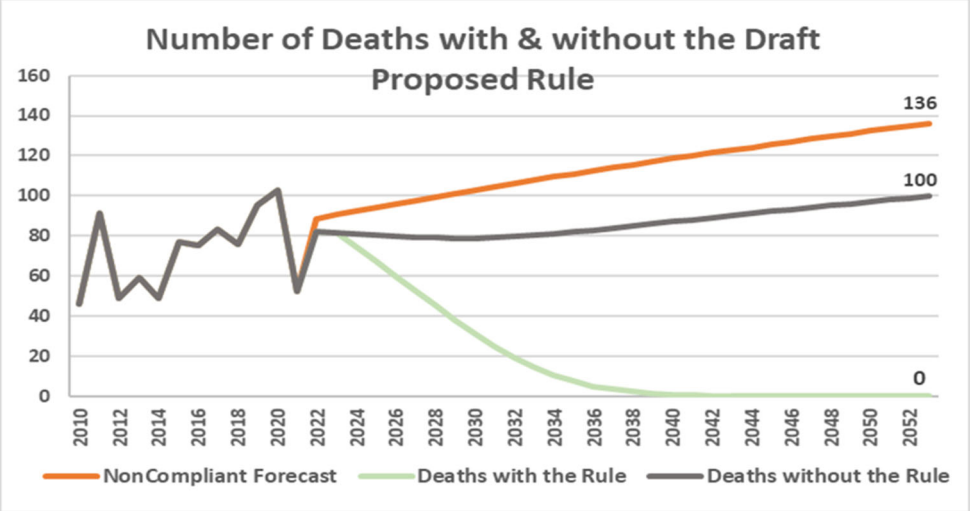

Figure 17: Number of Deaths with and without the Draft Proposed Rule

Finally, staff multiplied the number of deaths in each year by the $11.6 million VSL updated each year by real income growth to calculate the societal cost of deaths under the draft

[84] Figure 17 also shows an estimate of the number of deaths in the absence of compliant generators in the future. Although this situation is only hypothetical given current levels of compliance with the voluntary standards, it represents the conditions before the arrival of this new decade. Under those conditions, annual deaths in 2053 would have reached 136.

proposed rule and without it. The difference between these two estimates are the societal cost savings associated with the reduction in the number of deaths, as shown in Figure 18.

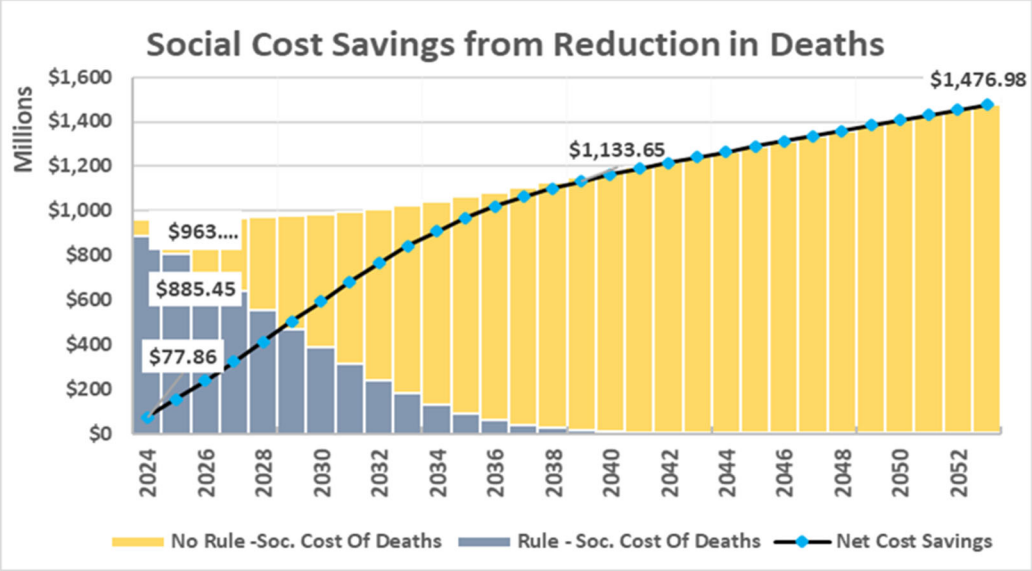

Figure 18: Social Cost Savings from Reduction in Deaths, 2024-2053

Staff estimates that in the first year of the rule (2024), compliant portable generators would prevent an estimated 6.5 deaths for an undiscounted benefit of approximately $77.86 million; while in the last year of the study period (2053), portable generators would prevent an estimated 99.8 deaths and benefits would reach $1.48 billion. Over 30 years, portable generators would prevent an estimated 2,148 deaths for an aggregate benefit of $29.34 billion undiscounted, $16.64 billion discounted at 3 percent, and $8.63 billion discounted at 7 percent.

D. Future Injuries Related to Portable Generators and Societal Savings from the Draft Proposed Rule

Similar to the estimates described in section IV.C, staff forecasted the number of future injuries using injury rates per million portable generators with its forecast of portable generators in use by type of compliance throughout the 30-year study period. First, staff assumed injuries with noncompliant generator would stay at the same rates observed between 2004 through 2021, as shown in Table 17. Next, staff adjusted the injury rates per million for noncompliant generators by the efficacy of each voluntary standard to estimate the rates per million generators compliant with each standard. Those estimates are presented in the bottom two rows of Table 17.

Table 17: Injury Rates per Million Generators by Generator Compliance

From 2004-2021	Hospital Admissions	Emergency Department	Doctor / Clinic's Visit
Average Annual Number of Portable Generators in Use	18,343,230	18,343,230	18,343,230
Average Annual Number of Injuries	406	976	2,932
Rate per Million for Noncompliant Generators[85]	22.1325	53.2106	159.8580
Rate per Million G300 Compliant Generator[86]	3.3939	9.6505	28.5259
Rate per Million UL 2201 Compliant Generator[87]	0.0269	0.1897	0.7423

Staff multiplied the number of million generators in use of each compliance type by the corresponding rates per million presented in the table above to create a projection of injuries for the 30-year period of analysis. Figure 19 shows the number of averted injuries by treatment type over the 30-year period of analysis.

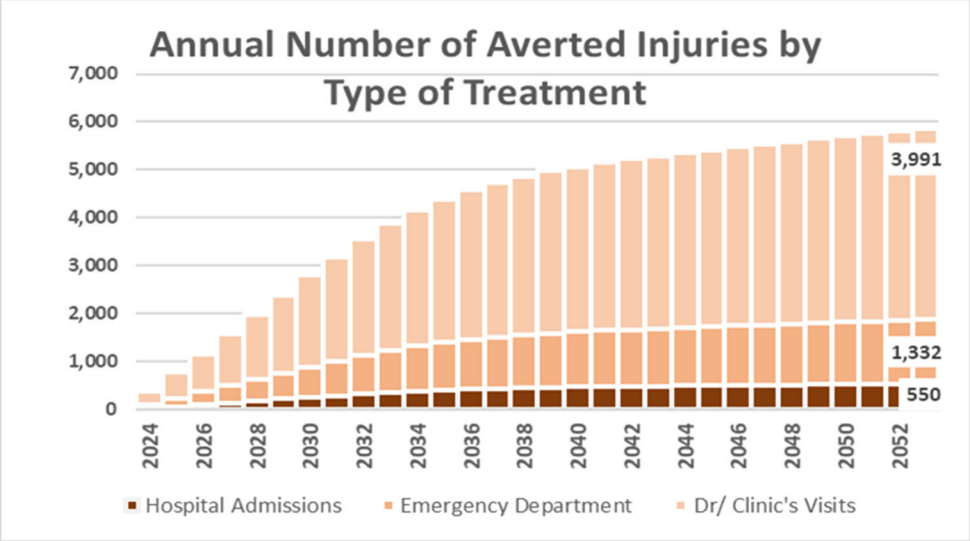

Figure 19: Number of Averted Injuries by Type of Treatment, 2024-2053

To calculate the benefits of prevented injuries, staff estimates the societal cost of injuries without the draft proposed rule and under the draft proposed rule. The difference of these two estimates are the societal savings associated with a reduced level of injuries. In each year of the study, staff estimated the social cost of injuries, multiplying the number of forecasted injuries multiplied by the societal cost of each type of injury (see Table 10) . Figure 20 presents the cost

[85] Rate determined by dividing the Average Annual Number of Injuries by Average Annual Number of Portable Generators in Use, then multiplied by 1 million.

[86] Rate determined by multiplying the average annual number of injuries of each severity by the efficacy rate of the G300 voluntary standard in protecting injuries of such severity.

[87] Rate determined by multiplying the average annual number of injuries of each severity by the efficacy rate of the UL 2201 voluntary standard in protecting injuries of such severity.

of injuries with and without the rule, as well as the net social cost saving from implementation. The net savings in 2024 are $20.50 million and reached $312.58 million in 2053.

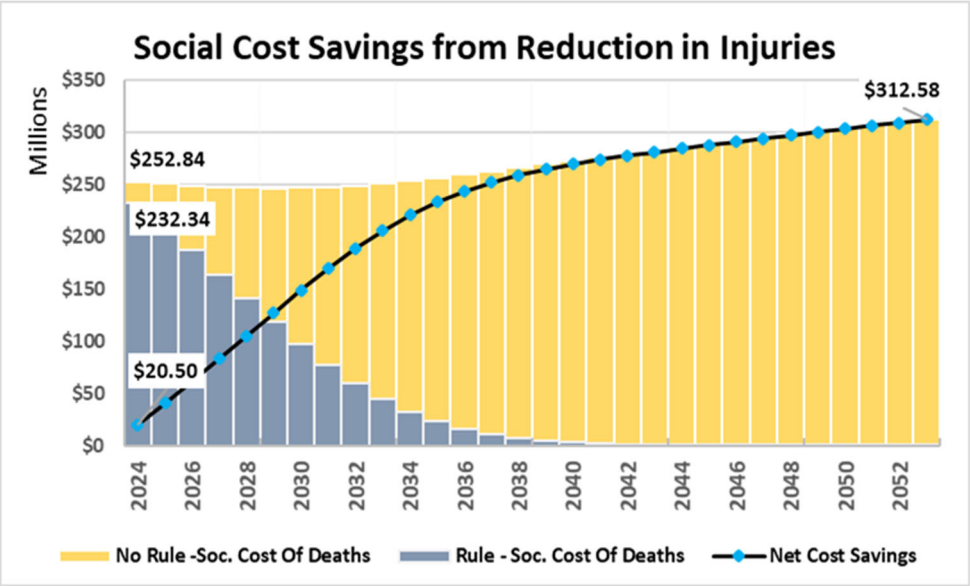

Figure 20: Social Cost Savings from Reduction in Injuries, 2024-2053

Staff estimates that the draft proposed rule would prevent an estimated 126,387 injuries over the 30-year period of analysis, saving a total of $6.73 billion in undiscounted societal costs, $3.86 billion discounted at 3 percent, and $2.04 billion discounted at 7 percent.

E. Annualized and Per Unit Benefits of Draft Proposed Rule

This section converts the aggregate benefits over the 30-year study period into annualized[88] and per-unit outputs.[89] Staff presents both these metrics to convey a holistic perspective of the impact from this draft proposed rule.

Table 18 summarizes the benefits of the draft proposed rule in annualized terms:

Table 18: Annualized Benefits of the Draft Proposed Rule

Prevented Casualties	**Annualized Benefits ($M)**		
	Undiscounted	**3% Discount**	**7% Discount**
Deaths	$977.85	$848.90	$695.08
Injuries	$224.24	$197.10	$164.05
Total Benefits	**$1,202.09**	**$1,046.00**	**$859.13**

[88] An annualized output converts the aggregate benefits over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the benefits among different rules or policy alternatives that may have different timelines; or those that have similar timelines but benefits for one are front-loaded while the other's maybe backloaded.

[89] A per-product metric expresses the benefits from the rule in one unit of product. This metric is helpful when assessing the impact in marginal terms; for example, comparing costs to an increase in retail price.

Table 19 summarizes the cost of the draft proposed rule in per unit[90] terms:

Table 19: Per Unit Benefits of the Draft Proposed Rule

Prevented Casualties	Per Unit Benefits ($)		
	Undiscounted	3% Discount	7% Discount
Deaths	$390.39	$221.43	$114.78
Injuries	$89.52	$51.41	$27.09
Total Benefits	**$479.92**	**$272.84**	**$141.88**

V. Net Benefits Analysis

Staff assessed the relation between benefits and costs of the draft proposed rule. Staff found that the benefits of the rule outweighed the costs by a factor of 7.02, when discounted at 3 percent.

Table 20 displays annualized metrics for both the benefits and costs of the draft proposed rule. The table displays both net benefits (difference between benefits and costs) and the benefit-cost ratio (benefits divided by costs) to assess the cost-benefit relationship.

Table 20: Annualized Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$1,202.09	$1,046.00	$859.13
Costs	$154.43	$148.94	$143.56
Net Benefits (Benefits – Costs)	**$1,047.65**	**$897.06**	**$715.57**
B/C Ratio	**7.78**	**7.02**	**5.98**

Table 21 compares the benefits and costs on a per-unit basis, to add a marginal value perspective.

[90] Staff calculates per-unit metrics dividing the 30-year total by the number of products modified with the proposed draft rule minus those made compliant without the rule.

Table 21: Per-Unit Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Per Unit Net Benefits ($)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$479.92	$272.84	$141.88
Costs	$61.66	$38.85	$23.71
Net Benefits (Benefits – Costs)	**$418.26**	**$233.99**	**$118.17**
B/C Ratio	**7.78**	**7.02**	**5.98**

Overall, the draft proposed rule has a benefit-cost ratio of 7.02 when comparing benefits and costs discounted at 3 percent. That means, for every $1 in cost, the draft proposed rule generates a return of $7.02 in benefits from mitigated deaths and injuries.

A. Sensitivity Analysis

1. Increased Compliance in the Baseline

As mentioned earlier in the analysis, even in the absence of the rule, there are a number of portable generators for sale in the market that currently comply with PGMA G300, and a smaller number of generators that comply with UL 2201. Based on information provided by large U.S. manufacturers about their existing models and plans, which was then supported by an analysis of portable generators for sale online, staff estimated that the current level of compliance with the sensor and shutoff requirement (i.e.: PGMA G300) is at 30 percent, while compliance with both requirements (i.e.: UL 2201) is at 5 percent of total annual sales. Staff also assumed that in the absence of the draft proposed rule those compliance rates would stay constant in future years.

Since compliance with either standard can potentially reduce the costs and benefits of the draft proposed rule, staff conducted a sensitivity analysis to assess the significance of a higher level of compliance in the baseline scenario (e.g., no draft proposed rule implemented) on the net benefits of the draft proposed rule. For such purpose, staff assumed an increased level of compliance with PGMA G300 of 60 percent – or twice the level of compliance considered in the main analysis -- while maintaining the level of compliance with UL 2201 at 5 percent.[91] This assumption changes the baseline scenario (the scenario without the rule), which causes most of the cost and benefit estimates in the primary analysis to change.

Table 22 presents the annualized and per product cost of the main analysis and this sensitivity analysis by cost category. In summary, assuming higher compliance with the PGMA G300 voluntary standard reduces the annualized cost of implementing the rule from $148.94 to $132.31, and the cost per product from $38.85 to $34.48.

[91] Except for one manufacturer that currently produces UL 2201 compliant generators, manufacturers surveyed by staff indicated they do not have a clear path or plans to become compliant with UL 2201.

Table 22: Sensitivity Analysis – Change in Annualized and Per Product Cost of the Rule

Cost Categories (present values discounted at 3%)	Annualized Cost ($M)		Cost per Product ($)	
	Main Analysis	Sensitivity at 60 percent	Main Analysis	Sensitivity at 60 percent
Manufacturing Cost	$120.86	$113.58	$31.53	$29.60
Model Redesign and Testing	$10.33	$8.54	$2.69	$2.23
CO Sensor Replacement	$16.90	$9.45	$4.41	$2.46
Deadweight Loss	$0.85	$0.74	$0.22	$0.19
Total Cost	**$148.94**	**$132.31**	**$38.85**	**$34.48**

As with the costs, the benefits of the draft proposed rule decrease with a higher level of PGMA G300 compliance in the baseline scenario (without the rule). The higher PGMA G300 compliance in the baseline scenario (without the rule) leads to a lower number of deaths and injuries to address; and hence a lower number of deaths and injuries averted by the rule,[92] as shown in Figure 21. The dashed lines show the numbers of deaths averted as a result of implementation of the draft proposed rule under the assumptions of the main analysis and this sensitivity analysis; while the solid lines show the numbers of injuries averted under each scenario. By 2053, the rule would avoid 820 injuries and 36 deaths less than in the main analysis.

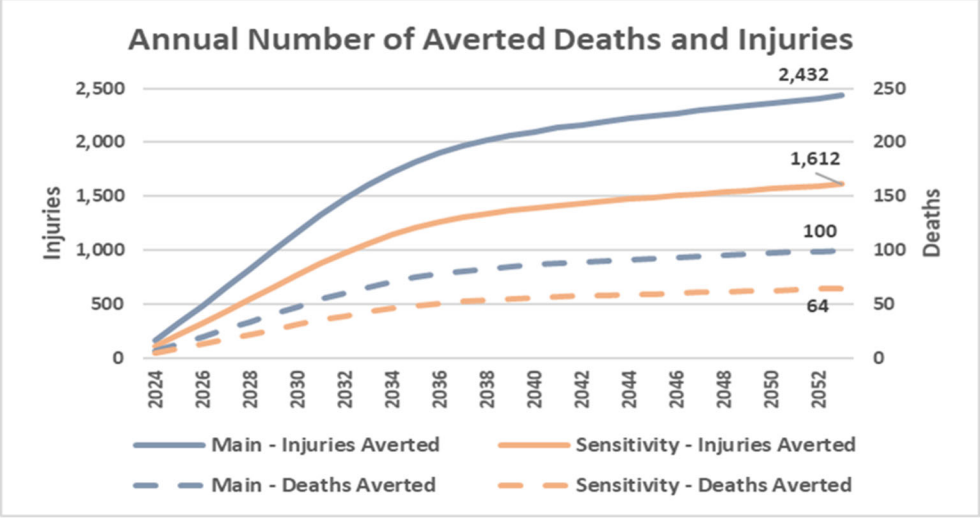

Figure 21: Sensitivity Analysis – Averted Deaths and Injuries, 2024-2053

Table 23 presents the annualized and per product benefits of the main analysis and the corresponding metrics for this sensitivity analysis. A higher compliance with the PGMA G300

[92] Higher compliance with the requirements of PGMA G300 means a lower baseline number of deaths and injuries than when compliance with PGMA G300 is lower (such is the case in the main analysis presented in this report).

voluntary standard reduces the annualized benefits from the draft proposed the rule from $1,046 million to $678.17 million, and reduces the benefits per product from $272.84 to $176.72.

Table 23: Sensitivity Analysis – Change in Annualized and Per Product Benefits of the Rule

Benefits (present values discount at 3%)	Annualized Benefit ($M)		Benefit per Product ($)	
	Main Analysis	Sensitivity at 60 percent	Main Analysis	Sensitivity at 60 percent
Deaths	$848.90	$548.20	$221.43	$142.85
Injuries	$197.10	$129.96	$51.41	$33.87
Total Benefits	**$1,046.00**	**$678.17**	**$272.84**	**$176.72**

Table 24 displays annualized net benefits and benefit-cost ratios of the draft proposed rule in the main analysis and this sensitivity analysis. Even with higher compliance with PGMA G300, the implementation of the rule generates annualized net benefits of $545.86 million due to reduced deaths and injuries. In this scenario, every $1 in costs produces $5.13 in benefits.

Table 24: Sensitivity Analysis – Change in Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Main Analysis	Sensitivity at 60 percent	Main Analysis	Sensitivity at 60 percent
Benefits	$1,046.00	$678.17	$272.84	$176.72
Costs	$148.94	$132.31	$38.85	$34.48
Net Benefits (Benefits – Costs)	**$897.06**	**$545.86**	**$233.99**	**$142.24**
B/C Ratio	**7.02**	**5.13**	**7.02**	**5.13**

2. Further Sensitivity Analyses of Compliance Levels in the Baseline

Arguably, there is a significant degree of uncertainty about the levels of compliance with the sensor/shutoff and emission requirements in the voluntary standards. In response to the potential imprecision about the benefits and costs under uncertain levels of compliance, staff decided to conduct additional sensitivity analyses at threshold levels of compliance in order to produce a more comprehensive assessment of the benefits and costs of the draft proposed rule. The threshold levels of compliance used for this purpose may not be realistic -either overstating or understating compliance with particular requirements of the standards-; but are useful to illustrate the direction of the benefit-cost analysis under these threshold situations.

With this objective in mind, staff conducted a sensitivity analysis that increased compliance with the sensor/shutoff requirement (i.e.: PGMA G300) from the estimated 30 percent used in the main analysis to 80 percent (above the rate of 60 percent tested in the previous sensitivity analysis subsection), while maintaining compliance with the emissions requirement (i.e.: UL 2201) at 5 percent of total annual sales. This sensitivity analysis changed the baseline scenario assuming a higher rate of compliance with the sensor/shutoff requirement in the absence of the draft proposed rule, a rate that is assumed to stay constant in future years.

Table 25 displays annualized benefits, costs, net benefits and benefit-cost ratios of the draft proposed rule in the main analysis and this sensitivity analysis at 80 percent compliance rate with the sensor/shutoff requirement. Even with such high compliance rate with the sensor/shutoff requirement of the PGMA G300 in the baseline, the implementation of the rule generates annualized net benefits of $311.4 million due to reduced deaths and injuries. The benefits are less than half the benefits in the main analysis, and the cost of implementation are also lower. However, this modeled situation produces benefits that significantly exceed the costs, with every $1 in costs generating $3.56 in benefits.

Table 25: Sensitivity Analysis at 80 Percent Compliance Rate with Sensor/Shutoff Requirement – Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Main Analysis	Sensitivity at 80 percent	Main Analysis	Sensitivity at 80 percent
Benefits	$1,046.00	$432.95	$272.84	$112.75
Costs	$148.94	$121.55	$38.85	$31.65
Net Benefits (Benefits – Costs)	**$897.06**	**$311.40**	**$233.99**	**$81.09**
B/C Ratio	**7.02**	**3.56**	**7.02**	**3.56**

Staff also conducted sensitivity analysis that changed compliance with the emissions requirement (i.e.: UL 2201) from the estimated 5 percent used in the main analysis to 1 and 10 percent, while maintaining compliance with the sensor/shutoff requirement (i.e.: PGMA G300) at 30 percent of total annual sales. These sensitivity analyses changed the baseline scenario by assuming different rates of compliance with the emissions requirement in the absence of the draft proposed rule, which are then maintained constant throughout the period of analysis.

Table 26 displays annualized benefits, costs, net benefits and benefit-cost ratios of the draft proposed rule under these sensitivity analyses at 1 and 10 percent compliance rates with the emissions requirement (UL 2201). These compliance rates in the baseline have small impacts on the annualized net benefits with a change of less than $5 million in each case. Benefits and costs change in the opposite direction of the change in compliance rates; net benefits increase with lower compliance rates, and decrease with higher compliance rates in the baseline. Benefits still exceed costs by a factor of almost seven, with every $1 in costs generating $6.87 in benefits at the 1 percent compliance rate, and $7.20 at the 10 percent compliance rate.

Table 26: Sensitivity Analysis at 1 and 10 Percent Compliance Rate with the Emissions Requirement – Annualized and Per Product Benefits of the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Sensitivity at 1 percent	Sensitivity at 10 percent	Sensitivity at 1 percent	Sensitivity at 10 percent
Benefits	$1,053.90	$1,036.12	$263.77	$285.34
Costs	$153.49	$143.92	$38.41	$39.64
Net Benefits (Benefits – Costs)	**$900.42**	**$892.20**	**$225.36**	**$245.70**
B/C Ratio	**6.87**	**7.20**	**6.87**	**7.20**

B. Unquantified Benefits and Cost

The cost-benefit analysis measured the cost to consumers and producers pushed out of the market by calculating deadweight loss. However, staff was unable to quantify the increased utility to consumers from having safer portable generators. This utility is derived from the sense of additional safety or reduction in anxiety when operating the product knowing that the hazard has been mitigated. This benefit is in addition to the reduced deaths and injuries quantified in this analysis. Typically, intangible benefits, such as the utility from the perceived increased safety of a consumer product, would be measured by eliciting the willingness to pay (WTP) of consumers for feeling safer. Even though WTP estimates are not available, staff believes consumers would be willing to pay a positive amount,[93] with a magnitude unknown at this point; however, such positive value would indicate that the benefits estimated in this analysis are likely an underestimate of all benefits accrued to consumers.

Staff was also unable to quantify precisely the benefits of reducing injuries from the increased level of safety provided by the draft proposed rule's CO emissions requirement with respect to the outdoor operation of G300-compliant portable generators.[94] Although the hazard pattern of injuries is largely unknown because of minimal narratives from NEISS records, staff believes it is reasonable to assume that at least some of the injuries were caused by portable generators operated outdoors.[95]

Staff assumed the effectiveness shown in the simulations could be extended to all incidents; however, of the 511 deaths replicated in the simulations, less than 2 percent (8 deaths)

[93] For instance, a study found a positive WTP for auto safety devices such as airbags. See Mannering and Winston, "Automobile Air Bags in the 1990s: Market Failure or Market Efficiency?", *Journal of Law and Economics*, Vol. 38 No.2, Oct 1995.

[94] The shutoff systems required by PGMA G300 and UL 2201 are expected to perform well indoors; however, when the generator is operated outdoors, weather conditions, the direction of the generator exhaust, and other situational factors may lower the level of CO concentration near the generator and not actuate the shutoff system. Since G300 does not require a CO emission rate reduction, a G300 portable generator running outdoors that does not shut off presents the same risk of CO poisoning as a noncompliant generator.

[95] CPSC conducted a study that demonstrates this is not a rare occurrence (see section IV B).. Furthermore, since CPSC has reports of at least 79 deaths that occurred in the years 2004 through 2021 with the generator operating outside, it is reasonable to assume that injuries have also occurred in this scenario.

replicated the scenario of the generator operating outdoors the entire time, whereas CPSC's fatality data shows that 6 percent of the deaths were reported to have occurred with the generator operating outdoors (79 out of 1332 deaths, as of May 10, 2022). Thus, the outdoor scenario is underrepresented in the injury estimates. Taking into consideration the diminished CO concentrations around the portable generator when it is operated outside, staff believes the effectiveness rate of G300-compliant generators in reducing injuries may be overstated, and the benefits of implementing the emission requirements of UL 2201 are consequently understated. Staff requests information regarding CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors.

Depending on the emission control strategy that manufacturers use to meet the CO emission rate performance requirement in the draft proposed rule, it is possible product modifications could render portable generator engines with improved fuel-efficiency, as well as other improved characteristics, such as easier starting, altitude compensation, fuel adaptability, higher power, better reliability, and longer engine life. Staff did not quantify the secondary benefits associated with these features - such as potentially reduced fuel use, but believes that if these incremental benefits were realized, they would improve the overall benefit-cost ratio of the draft proposed rule.

An underlying assumption in this assessment is that there would be no behavioral adaptation in response to the reduced rate of CO emissions from portable generators under the draft proposed rule. However, consumers' perceptions of injury likelihood and health impacts may be affected by the reduced CO emissions and shutoff features under the rule, which may give consumers an overconfident sense of security. This, in turn, could result in less careful behavior, and increase warned-against practices.

VI. Staff Evaluation of the Voluntary Standards

As noted, there currently are two voluntary standards addressing CO poisoning from the use of portable generators: ANSI-approved ANSI/PGMA G300-2018 Safety and Performance of Portable Generators, and ANSI-approved UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition (referred to as PGMA G300 and UL 2201, respectively). Both of these existing standards require generators to shut off when certain concentrations of CO are present in the proximity of the generator. UL 2201 also requires a lower CO emission rate compared to the emission rates of existing generators.[96]

Staff found that the voluntary standards are not adequate without additional requirements including durability, functionality, reliability and tamper resistance, as described in TAB E, and found that some requirements in these two voluntary standards are effective when paired with the additional requirements in the draft proposed rule. In particular, under simulated conditions, the sensor/shutoff and emission requirements included in UL 2201 would have averted essentially all of the deaths related to portable generators.[97] Consequently, high levels of

[96] Staff estimates the CO emission rate in UL 2201 represents a CO emission rate reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule.

[97] As mentioned earlier in this document, the simulation experiment was conducted in coordination with the National Institute for Standards and Technology (NIST). The simulations replicated the scenarios of 511 actual fatalities in CPSC's databases. The analysis of those simulations found that under simulated conditions, generators compliant

compliance with these requirements would likely reduce deaths associated with consumers' use of portable generators. However, to achieve the level of simulated efficacy in real-life situations, there are a number of environmental factors and other considerations that must be addressed. These considerations create the need for additional requirements, which are either included in one of the standards but not in the other, as well as some which are not included in either standard. Some of these requirements relate to the shutoff system's construction, the ability of the system to self-monitor, and be tamper resistant (to ensure durability, functionality, and reliability). There are also requirements related to the inclusion of a CO shutoff notification system and labeling (to make the consumer aware of the reason for the shutoff), as well as requirements related to the inclusion of a notification marking the direction of the engine exhaust and instructions to direct the exhaust away from the occupied structures (to ensure safe operation outdoors), among others. Without these additional requirements, the real-world effectiveness of the standard is unlikely to achieve the simulated level of efficacy during the simulations. For these reasons, the draft proposed rule does not implement UL 2201 as the mandatory standard, but instead takes key requirements from both standards; and adds additional requirements needed to reduce the risk of CO poisoning from operation of portable generators by consumers.

Even if the Second Edition of the UL 2201 voluntary standard (2018) included all the requirements discussed in the previous paragraph; the need for a mandatory standard arises also as a result of a low level of manufacturer's compliance with the voluntary standard. Staff conducted a review of portable generator models available for sale and found that noncompliant generators are prevalent.[98] The large majority of models produced by smaller manufacturers abroad are noncompliant.[99] Staff also conducted surveys of large U.S. manufacturers regarding compliance with the standards and found that compliance with UL 2201 is minimal; with most manufacturers lacking a clear path for implementation or even plans to become compliant with UL 2201.

VII. Alternatives to the Draft Proposed Rule

Staff has identified five alternatives to the draft proposed rule that the Commission might consider to address the risks of deaths and injuries caused by CO poisoning from consumer use of portable generators: 1) implement the draft proposed rule, except for the emission requirements included in UL 2201 and changing the CO concentration limits required for shutoff to those in PGMA G300, 2) rely on the adoption of the requirements of the draft proposed rule into one of the voluntary standards, 3) issue a rule that relies on either UL 2201 2nd Edition or PGMA G300-2018 as they are currently written, 4) continue to conduct education and information campaigns, and 5) take no action. Each alternative is discussed in detail below.

with the sensor/shutoff requirements of PGMA G300 would have averted nearly 87 percent of deaths, while under simulated conditions, generators compliant with the additional CO emission rate requirement of UL 2201 along with its sensor/shutoff requirements would have averted nearly 100 percent of the deaths.

[98] Staff found several portable generator models with CO detection and shutoff features, as well as a few other generators compliant with the added reduced CO emissions feature; however, these are a relatively small share of the number of models available for sale.

[99] An additional benefit of a mandatory standard is that a may lead to a fairer and more competitive market, where large and small manufacturers in the U.S. or abroad produce compliant models.

A. *Implement the Draft Proposed Rule with the Exception of the Emission Requirements and CO Concentrations for Shutoff included in Voluntary Standard UL 2201*

An alternative to the draft proposed rule is to require portable generators' manufacturers to comply with PGMA G300-2018 voluntary standard with the modifications required to ensure durability, reliability, and safe operation of the sensor / shutoff system. Staff considered this alternative because it provides some reduction of risk of CO poisoning from portable generators in enclosed spaces, and also because implementation costs are likely lower, while current compliance with the voluntary sensor / shutoff requirement is higher (compared to compliance with the UL standard's emission requirement). This section describes the quantification of costs and benefits associated with this alternative, or Alternative 1, and the advantages and disadvantages of its potential implementation.

The first important difference between Alternative 1 and the main analysis is that Alternative 1 averts fewer deaths and more injuries would occur, with a corresponding decrease in gross societal benefits (372 more deaths and 11,135 more injuries over 30 years). Another difference is that the manufacturing and conversion costs are lower. Conversion costs per noncompliant portable generator model are lower than the corresponding conversion costs of implementing the draft proposed rule. As shown in Figure 22, the conversion cost curves under Alternative 1 are significantly lower than the conversion cost under the draft proposed rule (see Figure 6). For instance, if a thousand models are subject to conversion cost, under the draft proposed rule the cost of redesign per model reaches $195.01 thousand (see Figure 6), while it only reaches $48.95 thousand under Alternative 1.

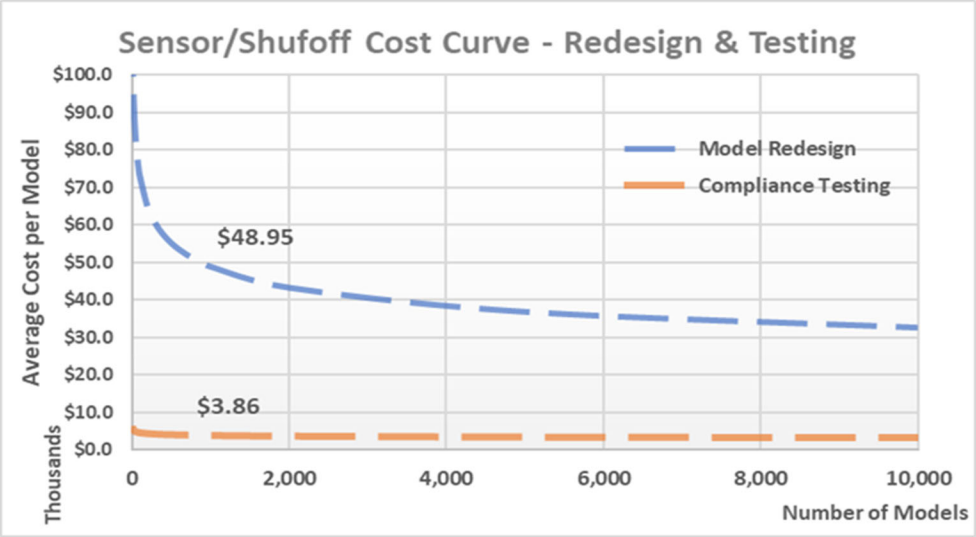

Figure 22: Alternative 1 – Conversion Cost Improvement Curve

The sensor replacement costs to consumers under Alternative 1 stay essentially unchanged from the draft proposed rule, because the number of sensors to be replaced and the cost of replacement in both scenarios are almost identical;[100] however, compared to other costs, sensor

[100] The number of sensor replacements increases slightly under Alternative 1. The reason for this is that the number of portable generators sold each year is slightly higher than in the main analysis because the lower cost of this alternative increased the average market prices of portable generators by a smaller fraction, and; hence, the annual number of portable generators sold at these lower prices, increases. More portable generators sold and in use means more sensor replacements are required every year; however, the impact is not highly significant.

replacement costs become much more prominent under this alternative, as the costs under other categories decrease, as shown in Figure 23. Also, as a result of lower manufacturing and conversion costs, the impact on the price of the product and the deadweight loss are lower under Alternative 1.

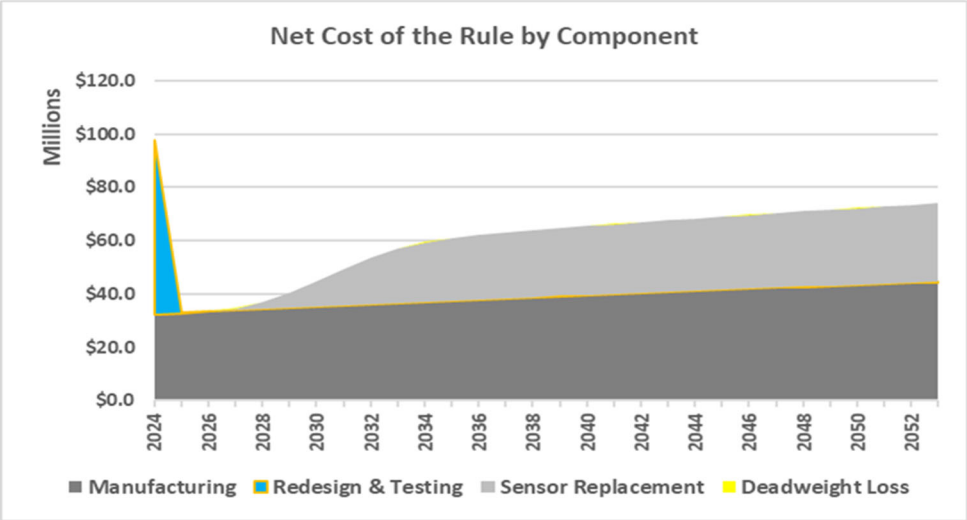

Figure 23: Alternative 1 – Cost of Alternative by Cost Component, 2024-2053

The conversion and manufacturing costs under Alternative 1 are a fraction of the corresponding conversion and manufacturing cost with the draft proposed rule. As displayed in Figure 24, the initial cost of implementation in 2024 represent slightly above one quarter of the cost under the draft proposed rule. After 2024 the costs under Alternative 1 increase from roughly a quarter of the cost of the draft proposed rule to more than two-fifths by 2053; the increase in cost is attributable to the increased significance of sensor replacement costs to consumers as the number of G300 products in use increases.

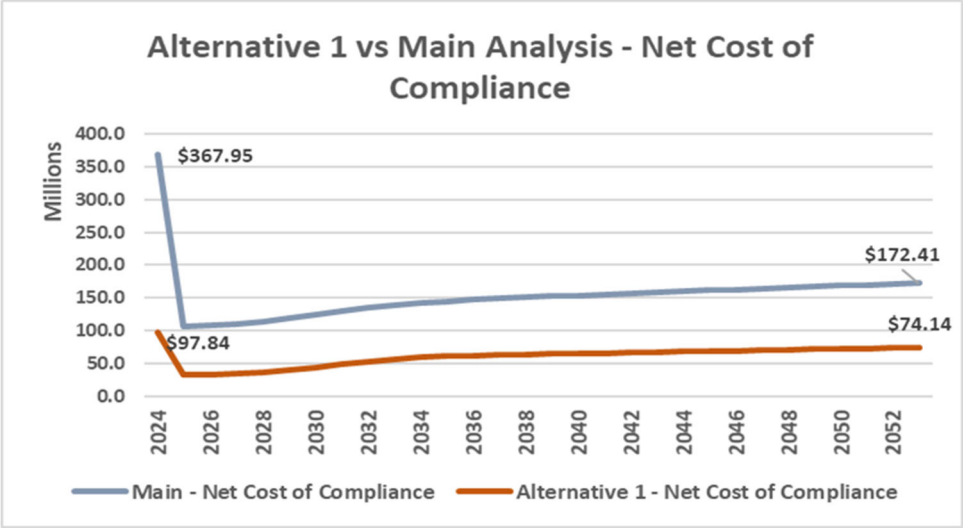

Figure 24: Alternative 1 – Cost Comparison with Draft Proposed Rule, 2024-2053

Table 25 presents the annualized and per product cost of the main analysis of the draft proposed rule and Alternative 1 by cost category. The annualized manufacturing cost of implementing only the sensor / shutoff requirements of the G300 voluntary standard represent

slightly more than one fourth of the cost of the main analysis of the rule, decreasing from $120.86 to $36.81; similarly, the annualized conversion costs associated with model redesign and testing decrease from $10.33 to $3.19. The annualized sensor replacement costs with the draft proposed rule and Alternative are of similar value because the number and cost of sensor replacement are comparable, but the deadweight loss experiences a significant reduction with Alternative 1 due to the reduced impact on market prices.

Table 25: Alternative 1 – Change in Annualized and Per Product Cost from the Rule

Cost Categories (present values discounted at 3%)	Annualized Cost ($M)		Cost per Product ($)	
	Main Analysis	G300	Main Analysis	G300
Manufacturing Cost	$120.86	$36.81	$31.53	$12.92
Model Redesign and Testing	$10.33	$3.19	$2.69	$1.12
CO Sensor Replacement	$16.90	$17.12	$4.41	$6.01
Deadweight Loss	$0.85	$0.08	$0.22	$0.03
Total Cost	**$148.94**	**$57.20**	**$38.85**	**$20.08**

The annualized costs from the main analysis to Alternative 1, as shown in Table 2, experience a relatively more significant drop than the per-product cost, because the annualized cost capture the impact of both the reduced cost of modifications per model and product, as well as the higher number of models and products modified under the draft proposed rule.[101]

Like the cost, the benefits of Alternative 1 are lower that the benefits of the draft proposed rule. The decrease in benefits is associated with the lower efficacy of the sensor / shutoff requirements of the G300 voluntary standard with respect to the efficacy of the draft proposed rule. Mandating the sensor / shutoff requirements of G300 would lead to a lower number of deaths and injuries than in the baseline situation at current rates of compliance; however, over the 30-year period of analysis, Alternative 1 would avert 372 fewer deaths and 11,135 fewer injuries than the rule. Figure 25 presents the annual number of deaths and injuries averted under Alternative 1 and under the draft proposed rule. The dashed lines show the numbers of deaths averted and the solid lines show the numbers of injuries averted under each scenario. By 2053, implementation of the emissions requirements of the draft proposed rule would lead to averting additional 517 injuries and 17 deaths during the 30-year period.

[101] All models and products that would have been sold as G300 compliant models and products under Alternative 1, need to be upgraded to UL 2201 under the draft proposed rule, so the main analysis involves the modification of a higher number of models and products than Alternative 1.

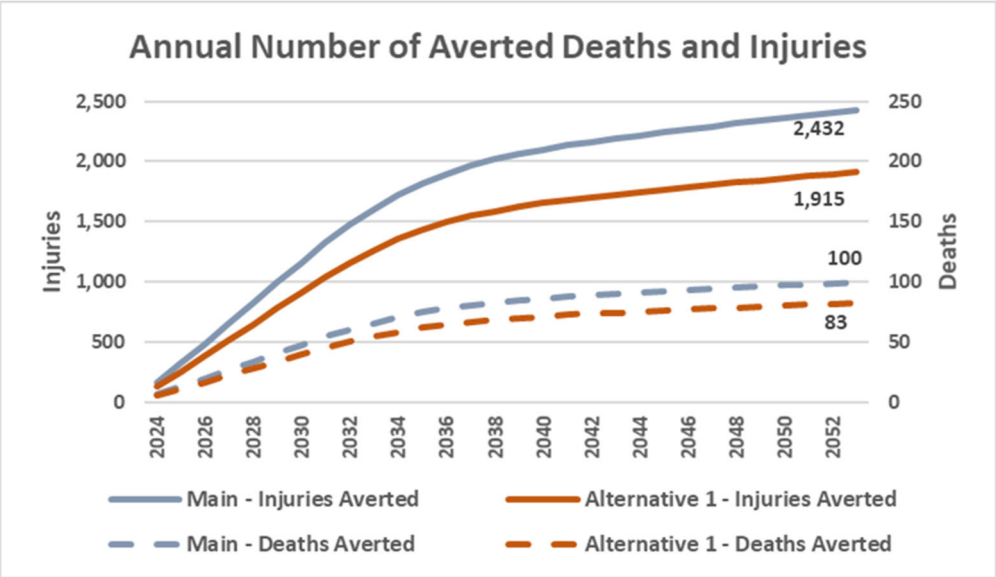

Figure 25: Alternative 1 – Averted Deaths and Injuries vs the Draft Proposed Rule, 2024-2053

Table 26 presents the annualized and per product benefit metrics of the draft proposed rule and Alternative 1. A mandatory standard that excludes the emissions requirement of UL 2201 would decrease annualized benefits from the draft proposed rule by almost $187 million as a result of the increased number of deaths and injuries, from $1,046 to $859.03 million per year. The per-product benefits presented in Table 26 are impacted by the number of products upgraded under each scenario; hence, a slighter higher per-product benefit is estimated under Alternative 1, because the number of products modified under Alternative 1 is smaller than the number of products upgraded under the rule.

Table 26: Alternative 1 – Change in Annualized and Per Product Benefits from the Rule

Benefits (present values at 3%)	**Annualized Benefits ($M)**		**Benefits per Product ($)**	
	Main Analysis	**G300**	**Main Analysis**	**G300**
Deaths	$848.90	$702.22	$221.43	$246.54
Injuries	$197.10	$156.82	$51.41	$55.06
Total Benefits	**$1,046.00**	**$859.03**	**$272.84**	**$301.60**

Table 27 presents a summary of the cost and benefit impacts of Alternative 1 with respect to the draft proposed rule. It presents annualized net benefits and benefit-cost ratios under Alternative 1 and the draft proposed rule respectively. The annualized net benefits of the draft proposed rule are $95.22 million higher than the annualized benefits under Alternative 1, indicating the draft proposed rule represents the best option in terms of societal savings because the draft proposed rule would prevent more deaths and more injuries, while maintaining a large net societal benefit.

Table 27: Alternative 1 – Change in Annualized and Per Product Net Benefits from the Rule

Benefits - Costs (present values disc. at 3%)	Annualized Net Benefits ($M)		Net Benefits per Product ($)	
	Main Analysis	G300	Main Analysis	G300
Benefits	$1,046.00	$859.03	$272.84	$301.60
Costs	$148.94	$57.20	$38.85	$20.08
Net Benefits	**$897.06**	**$801.84**	**$233.99**	**$281.52**

It is important to emphasize that the G300-compliant generator efficacy rates in reducing deaths and injuries may be overstated because the simulation analysis do not fully account for deaths and injuries produced during outdoor use of G300-compliant generators. G300-compliant generators running outside the home or other structure that can be occupied that do not shut off present the same risk of CO poisoning as a noncompliant generator. Therefore, the benefits (and net benefits) presented in Table 27 (under the headings G300) may exceed the real-life benefits (and net benefits) of implementation of this alternative.

B. Await Possible Adoption of the Draft Proposed Rule Requirements into UL 2201 Or PGMA G300

Alternative 2 proposes reliance on voluntary standard stakeholders[102] to adopt all the requirements included in the draft proposed rule into either the UL 2201 or the PGMA G300 voluntary standard. Staff does not recommend this alternative for two main reasons: 1) the likelihood of obtaining consensus on a voluntary standard that has all the requirements of the draft proposed rule is very low,[103] and 2) currently, there is low compliance with either voluntary standard. Therefore, staff concludes that it is reasonable to assume that even if a voluntary standard with all of the draft proposed rule's requirements were to achieve consensus, it would not be substantially complied with by manufacturers.

C. Issue a Rule That Relies on Either UL 2201 2nd Edition or PGMA G300-2018 As They Are Currently Written

This alternative to the draft proposed rule is a rule that requires portable generators to comply with either the UL 2201 (2nd Edition; 2018) or PMGA G300-2018. Staff does not recommend this alternative because, as stated earlier, neither standard is adequate. Staff assesses that the shutoff requirements in PGMA G300 would leave 69 of the 511 fatalities unaddressed and other requirements are not adequate such as those for tamper resistance, requirements for verifying compliance with the shutoff requirements, and notification and labeling requirements. Staff assesses that the CO emission rate and shut off performance requirements from UL 2201 are

[102] For instance, stakeholders on the STP for UL 2201 or a canvass committee for PGMA G300.

[103] PGMA's technical director and members who are on the STP for UL 2201 voted against UL 2201. Nevertheless, in 2018, UL 2201 ultimately achieved consensus among the STP to receive ANSI recognition. (Per UL's operating procedures approved by the American National Standards Institute [ANSI], consensus is achieved by approval from two-thirds of respondents to a ballot (excluding abstentions) if a majority of STP members have returned the ballot.)

extremely effective in reducing the risk injury or death associated with CO poisoning from portable generators; however, this standard lacks the requirements necessary to ensure the durability, reliability, and functionality of the CO shutoff system and notification and labeling requirements.

D. Not Issue a Rule and Continue to Conduct Information and Education Campaigns

Staff considered the merits of continuing to conduct education and information campaigns without a rule, as an alternative to the draft proposed rule. Existing CPSC education and information campaigns on the hazards associated with CO and CPSC advocacy on smoke and CO alarm adoption could increase the presence of CO alarms in homes. Although CPSC staff supports and acknowledges the importance of such efforts, staff does not believe that these efforts are the most effective way to reduce CO poisonings, or that these efforts should take the place of performance requirements that would directly address the CO poisoning hazard associated with portable generators. This is reinforced by staff's finding that the annual number of generator-related CO deaths have not declined in recent years, and actually appear to be increasing.

CPSC recommends that every home should have one or more CO alarms. Per staff's case study of CO exposures in homes from generators operating outside after Hurricane Ida (see TAB D), CO alarms helped prevent injuries and likely saved lives in the incidents with homes that had working CO alarms and likely could have also helped in the incidents where homes did not have working CO alarms. CO alarms are effective, and can be lifesaving devices, but they should be considered the *last* line of defense. The accepted hierarchy for reducing the risk from a hazard is to reduce it at its source and if that is not possible, then guard against the hazard. The draft proposed rule reduces the hazard at the source.

E. Take No Action

Finally, CPSC considered the merits of taking no action. An assessment of the trends in deaths and injuries and the low adoption of the voluntary standards, indicate this problem will not correct itself. Indeed, incidents with both injuries and deaths will likely increase as more noncompliant portable generators enter the market and are put in use. Meanwhile, society will still bear the burden of preventable fatalities and injuries from CO related deaths and injuries associated with portable generators. Over the next 30 years at current levels of compliance with the voluntary standards, deaths are expected to exceed 2,600 with roughly 154 thousand injuries, and a total societal cost in excess of $22.2 billion (discounted at 3 percent).

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TAB C: Draft Initial Regulatory Flexibility Analysis of the Draft Proposed Rule for Portable Generators

United States
Consumer Product Safety Commission
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Memorandum

TO: Janet Buyer, Project Manager
Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

DATE January 28, 2023

FROM: David Olson
Directorate for Economic Analysis

SUBJECT: Draft Initial Regulatory Flexibility Analysis of the Draft Proposed Rule for Portable Generators

I. Introduction

When an agency publishes a proposed rule, Section 603 of the Regulatory Flexibility Act (RFA), 5 USC 601 – 612, generally requires that the agency prepare an initial regulatory flexibility analysis (IRFA) that describes the impact that the rule would have on small businesses and other entities, unless the head of the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Under Section 603(b) of the RFA, each IRFA must address:

(1) a description of why action by the agency is being considered;

(2) a succinct statement of the objectives of, and legal basis for, the proposed rule;

(3) a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

(4) a description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

(5) an identification to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the proposed rule.

The IRFA must also describe any significant alternatives to the proposed rule which would accomplish the stated objectives and minimize any significant economic impact on small entities. This memorandum provides the IRFA of the draft proposed rule.

II. Background

In 2016, staff of the U.S. Consumer Product Safety Commission (CPSC) delivered to the Commission a draft proposed rule intended to address the risk of carbon monoxide (CO) poisoning associated with portable generators (Buyer, 2016). As proposed, the rule would have

limited the CO emission rates of then-current portable generators by about 75 to 90 percent. The Commission voted to approve publication of the draft proposed rule, and on November 21, 2016, published a notice of proposed rulemaking (NPR) in the *Federal Register* (81 FR 83556). Two years later, in 2018, two voluntary standards for portable generators adopted CO hazard mitigation requirements into their existing standards: ANSI-approved ANSI/PGMA G300-2018 Safety and Performance of Portable Generators, and ANSI-approved UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition (referred to as PGMA G300 and UL 2201, respectively). Both standards require generators to shut off when specified concentrations of CO are present around the generator. UL 2201 also requires a specific, relatively lower CO emission rate, compared to the emission rates of most existing generators.[1] Section 7 of the Consumer Product Safety Act (CPSA) requires the Commission to rely on an existing voluntary standard, rather than promulgating a rule, if the voluntary standard is likely to eliminate or adequately reduce the risk of injury associated with these products, and if compliance with the voluntary standard is likely to be substantial. Staff developed this draft proposed rule as a supplemental notice of proposed rulemaking (SNPR) that reflects and builds upon the industry's steps to address the CO hazard through the newest editions of these two voluntary standards.

III. Discussion

A. Reason for Agency Action

The intent of this rulemaking is to reduce the risk of death or injury from CO poisoning resulting from consumer use of portable generators. The Directorate for Epidemiology, Division of Hazard Analysis (EPHA) reports that there were at least 1,332 deaths involving portable generators from 2004 through 2021 as of May 10, 2022 (see TAB A of this briefing package), or an average of about 74 annually. From 2004 through 2021, there were a total of 17,569 nonfatal CO poisonings involving portable generators that were treated in hospital emergency departments (about 976 annually); 7,308 hospital admissions (an average of 406 per year); and 52,782 medically-attended injuries treated in other settings (an estimated 2,932 per year). The Commission is considering promulgation of the draft proposed rule to reduce these generator-related CO injuries and deaths and the associated societal costs. Although there are two voluntary standards that address CO poisoning from portable generators, staff assesses that there is not substantial compliance with these voluntary standards throughout the industry, nor would adoption of either of these standards reduce the hazard risk as effectively as the draft proposed rule.

B. Objectives and Legal Basis for the Draft Proposed Rule

The objective of the draft proposed rule is to reduce deaths and injuries resulting from exposure to CO associated with portable generators. The Commission published an advance notice of proposed rulemaking in December, 2006, which initiated this proceeding to evaluate regulatory options and potentially develop a mandatory standard to address the risks of CO poisoning

[1] Staff estimates the emission rate in UL 2201 represents a CO emission rate reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule.

associated with the use of portable generators. Compliance with the voluntary standards has not increased substantially since the publication of their 2018 revisions while the number of deaths and injuries has continued to increase; therefore, staff concluded mandatory standards are required to reduce the significant hazards associated with this consumer product. The draft proposed rule establishing these mandatory standards would be issued under the authority of the Consumer Product Safety Act (CPSA).

C. Small Entities to Which the Draft Proposed Rule Would Apply

The draft proposed rule would apply to all entities that manufacture or import portable generators that are powered by spark-ignited (SI) engines. Based on data collected by Power Systems Research, along with other market research, staff identified 110 manufacturers of generators that have at some time supplied portable generators to the U.S. market. Most of these manufacturers were based in other countries. Staff identified 13 domestic manufacturers of gasoline, natural gas, and propane-powered portable generators, four of which would be considered small based on the Small Business Administration (SBA) size guidelines. SBA establishes guidelines for small entities using the North American Industry Classification System (NAICS). For this initial regulatory flexibility analysis of portable generators, staff used the NAICS category 335312 (Motor and Generator Manufacturing) which categorizes manufacturers as small if they have fewer than 1,250 employees.[23] Three of the four small manufacturers are primarily engaged in the manufacture or supply of larger, commercial, industrial, or backup generators, or other products, such as electric motors, that are not subject to the draft mandatory standard. For the remaining small manufacturer, portable generators likely account for a significant portion of the firm's total sales.

Using the same sources of data described above, staff identified more than 90 firms that have produced or imported gasoline, natural gas, and propane-powered portable generators. However, in most cases, these firms have not imported portable generators regularly, or portable generators account for an insignificant portion of their sales. Of these 90 firms, staff assessed that 20 may be small importers[4] of gasoline and propane-powered portable generators that could be affected by the draft proposed rule.[5]

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[2] Domestic manufacturers were chartered as those that manufacture portable generators within the country. Firms were also classified as domestic manufacturers despite importing major components, such as engines.

[3] These four small, domestic manufacturers are categorized based on firm size data from Hoovers, Inc., Dun & Bradstreet (D&B).

[4] Firms that import portable generators may be categorized under different NAICS codes. Some firms may be under NAICS code 423610 Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers, while others are under NAICS code 449210 Electronics and Appliance Retailers. The SBA size guidelines categorize small business under NAICS 423610 as those with 200 or fewer employees, while those operating under NAICS category 449210 are small if their average annual receipts do not exceed $35 million.

[5] Staff used data from D&B to determine that these 20 small business comply with the SBA guidelines for their respective NAICS codes (in 2016). Although, updated sales of individual models / OEM do not align perfectly with prior year sales, the size of these businesses is believed to be in line with the 2016 assessment. Revenue estimates were generated based on the average sale price of generators and historic sales volumes. This approach likely underestimated firm-wide revenues due to the omission of other products, but does provide us a conservative estimate of revenue.

D. Compliance Requirements of the Draft Proposed Rule, Including Reporting and Recordkeeping Requirements

The CPSA requires manufacturers (the term includes importers) to certify that their products comply with applicable CPSC standards and regulations. 15 U.S.C. § 2063(a)(1). If the Commission should finalize a portable generator rule, manufacturers, including importers, would need to certify that the product conforms to the standard. For products that manufacturers certify, manufacturers would issue a general certificate of conformity (GCC). The requirements for the GCC are stated in Section 14 of the CPSA. Among other requirements, each certificate must identify the manufacturer or private labeler issuing the certificate and any third-party conformity assessment body on whose testing the certificate depends, the place of manufacture, the date and place where the product was tested, each party's name, full mailing address, telephone number, and contact information for the individual responsible for maintaining records of test results. The certificates must be in English. The certificates must be furnished to each distributor or retailer of the product and to the CPSC, if requested.

E. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rule

At the time of this document, no other Federal rules duplicate, overlap, or conflict with the draft proposed rule.

IV. Potential Impact on Small Businesses

A. Impact on Small Manufacturers

To comply with the draft proposed rule, small manufacturers would incur the costs to redesign, test, and manufacture compliant generators. As discussed in the preliminary regulatory analysis of the draft proposed rule (TAB B of this briefing package), the undiscounted cost of manufactuting, redesigning, and testing portable generators to comply with the draft proposed rule is expected to be, on average, about $53.38[6] per generator, or $34.22 discounted at 3 percent. These costs represents roughly 5 and 3 percent of the average price of a portable generators, respectively.

As mentioned in the regulatory analysis, the retail prices staff observed for portable generators from manufacturers and importers of all sizes ranged from a low of $149 to $6,649, depending upon the characteristics of the generator. On a per unit basis, the draft proposed rule is expected to increase the manufacturing costs of portable generators by an average of $34.22, discounted at 3 percent. Generally, impacts that exceed one percent of a firm’s revenue are considered to be potentially significant. Depending on the size of the generator, the average cost of the upgrade would be between 0.5 percent and 23 percent of the retail prices (or average revenue) of generators; therefore the draft proposed rule could have a significant impact on manufacturers and importers that receive a significant portion of their revenue from the sale of the lowest priced portable generators.

[6] This estimate only include the cost of manufacturing upgraded portable generators as a result of the draft proposed rule (portable generators that would not have been upgraded otherwise) and conversion costs for redesigning and testing portable generator models.

Costs could be higher for small manufacturers because their R&D cost is spread among fewer units and their variable costs have a harder time reaching economies of scale. [78]

B. Impact on Small Importers

For small importers, the impact of the draft proposed rule would be similar to small manufacturers. Staff expects that the foreign suppliers would pass much of the costs of redesigning and manufacturing portable generators to comply with the draft proposed rule to their domestic distributors. Therefore, the cost increases experienced by small importers would likely be similar to small manufacturers.

In some cases, the foreign suppliers could opt to withdraw from the U.S. market rather than incur the costs of redesigning their generators to comply with the draft proposed rule. If this occurs, the domestic importers will have to find other suppliers of portable generators or exit the portable generator market. Exiting the portable generator market could be considered a significant impact if portable generators accounted for a significant percentage of the firm's revenue. At least three of these firms focus on mobile generators, which are not the same as portable and are generally larger products that are trucked to a site in need of electricity for industrial or business requirements.

Small importers will be responsible for issuing a GCC certifying that their portable generators comply with the draft proposed rule should it becomes final. However, importers may rely upon testing performed and GCCs issued by their suppliers in complying with this requirement.

C. Alternatives Considered to Reduce the Burden on Small Entities

Under section 603(c) of the Regulatory Flexibility Act, an initial regulatory flexibility analysis should "contain a description of any significant alternatives to the proposed rule which accomplish the stated objectives of the applicable statutes and which minimize any significant impact of the proposed rule on small entities." CPSC staff examined several alternatives to the draft proposed rule which could reduce the impact on small entities. These alternatives are discussed, along with the reasons staff does not recommend them, in section VII of the preliminary regulatory analysis (TAB B of this briefing package).

V. Summary and Request for Comments

Staff identified four small generator manufacturers and 20 small portable generator importers that could be impacted by the draft proposed rule. CPSC staff estimates that, on average, the requirements will increase the costs of manufacturing portable generators by about $34.22, discounted at 3 percent, as cited in the regulatory analysis (TAB B of this briefing package). The costs might be higher than average for lower volume manufacturers. The draft proposed rule impacts on small importers of portable generators are less clear.

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[7] As discussed earlier, the engine manufacturers would be expected to have higher production volumes and be able to spread the fixed costs of research & development, and retooling costs over a higher volume of production; therefore, the potential disproportionate impact on low-volume producers might be mitigated to some extent.

[8] Some large engine manufacturers supply engines to other -usually smaller- manufacturers of engine-driven tools, including portable generator manufacturers. These manufacturers include companies such as Honda, Briggs and Stratton, Kohler, and a few other firms based in China.

CPSC staff recommends that the Commission invite comments on this initial regulatory flexibility analysis and the potential impact of the draft proposed rule on small entities, especially small businesses. In particular CPSC staff is interested in comments on:

- the types and magnitude of manufacturing costs that might disproportionately impact small businesses or were not considered in this analysis,
- the costs of the testing and certification requirements of the draft proposed rule, and
- differential impacts of the draft proposed rule on small manufacturers or suppliers that compete in different segments of the portable generator market.

TAB D: Staff's Analysis on Carbon Monoxide Exposures Inside Homes That Resulted from Portable Generators That Were Operating Outdoors After Hurricane Ida

United States
Consumer Product Safety Commission
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Memorandum

DATEJanuary 28, 2023

TO: The File

THROUGH: Mark E. Kumagai, Associate Executive Director, Directorate for Engineering Sciences

Caroleene Paul, Director,
Division of Mechanical and Combustion Engineering, Directorate for Engineering Sciences

FROM: Janet Buyer, Mechanical Engineer,
Division of Mechanical and Combustion Engineering, Directorate for Engineering Sciences

SUBJECT: Staff's Analysis on Carbon Monoxide Exposures Inside Homes That Resulted from Portable Generators That Were Operating Outdoors After Hurricane Ida

I. Introduction

This memorandum provides staff's analysis of incidents of carbon monoxide (CO) exposures inside homes resulting from portable generators operating outdoors after Hurricane Ida caused widespread power outages in Louisiana in August and September 2021. It also supports staff's draft proposed rule to address the CO poisoning hazard posed by portable generators.

II. Background

In early September 2021, staff of the U.S. Consumer Product Safety Commission (CPSC) received an email initiated by an official in the office of the Louisiana State Fire Marshall. This official expressed alarm about the number of 911 calls fire departments were responding to due to CO from stationary generators[1] entering homes in dangerous concentrations from generators' use after Hurricane Ida. Hurricane Ida made landfall on the morning of August 29, 2021, in Grand Isle, LA, as a category 4 hurricane, causing power outages to more than a million people in the greater New Orleans area. The official said that the State Fire Marshal's office was receiving calls on the same issue from master code professionals, certified building officials, electrical contractors, and a major retailer of stationary generators. Staff communicated with this official and, considering the information provided by the State Fire Marshal, as well as news

[1] Stationary generators are sometimes also referred to as residential, home, whole home, house, backup, standby, emergency, fixed, or permanent generators, among other names.

articles on the matter,[2,3,4], staff initiated a more formal effort to investigate these incidents. CPSC's field staff contacted the State Fire Marshal, who in turn requested all fire departments in the areas where power outages were caused by Hurricane Ida to send to CPSC information on the stationary generator-related CO incidents to which they responded. After receiving information from a number of fire departments, staff learned that there were also incidents involving portable generators that were located outside where the exhaust migrated inside in dangerous concentrations; therefore, staff requested that fire departments send information on those incidents as well.

Most of the information CPSC has on these incidents is that which was provided by the responding fire department as a result of the consumer having called 911.[5] CPSC also was informed of six incidents involving stationary generators by five consumers who self-reported their incidents on www.saferproducts.gov but did not call 911 nor had the fire department visit their home and one incident which also did not involve a fire department response came to CPSC through a news article.[6] Because all of these incidents occurred in the aftermath of Hurricane Ida and fire departments were responding to numerous CO incidents in rapid succession, a number of fire departments informed staff that, due to the chaotic environment and limited resources at that time, they could only document an incident's general description before moving to the next incident, rather than write a detailed report. Staff initiated abbreviated investigations, on the first 200 homes about which staff received information, to (1) request the fire department report in case one was written but not initially provided to CPSC and (2) obtain more details of the incident from the consumer. This memorandum summarizes the portable generator incidents from this investigation.

III. Analysis of Findings

Staff has received information on 256 homes in which an incident of CO exposure occurred inside a home from a generator. Two hundred fifty of the homes involved 276 fire department responses (22 homes called 911 more than once). Sixty-six homes were known to involve a portable generator, and 103 homes were known to involve a stationary generator. For 36 homes, the fire department's documentation did not contain sufficient detail for staff to ascertain which type of generator was involved and staff was not able to reach a resident to find out, but in many of these, the fire department recommended that the generator be moved or not be

[2] "Carbon monoxide worries post-Ida prompt officials to take action" by Meg Gatto, 11/1/2021.

[3] "St. Tammany official wants law changed pertaining to generator placement" by Meg Gatto, 11/12/2021.

[4] "Lawmaker drafting legislation to address placement of whole home generators" by Meg Gatto, 11/23/2021.

[5] The following fire departments provided information to CPSC: Avondale, Baton Rouge, Central, Covington, Coteau, East Bank Consolidated, East Side Saint Charles, Harahan, Harvey, Houma, LaFourche, Leesville, Live Oak Manor, Livingston, Loranger, Marrero-Estelle, New Orleans, River Ridge, St. Tammany Parish Fire Districts 2 and 13, Terrytown, Third District, and Westwego. CPSC staff has information indicating that there are a number of other fire departments who also responded to generator-related CO calls. Staff encourages submission of additional incident information to CPSC, including any not necessarily associated with Hurricane Ida.

[6] After the first of staff's investigations were initiated, the reporter of the previous articles referred to in footnotes 2, 3, and 4 contacted CPSC to inquire about staff's efforts and wrote a fourth article ("Federal agencies looking into whole-home generator dangers after Hurricane Ida, Fox 8 reports" by Meg Gatto, 7/26/2022). In this article she included a link to www.saferproducts.gov so that consumers could report their incidents directly to CPSC. CPSC continues to encourage consumers to report their incidents, including any not necessarily associated with Hurricane Ida.

turned on until it was moved. For 51 homes, the fire department's documentation did not mention the source of CO (however the fire department provided the report to CPSC in response to staff's request) and staff was not able to reach a resident.

The fire department reported only three homes out of the 66 known to involve a portable generator in which the generator was inside the home. In two of these incidents, it was reported that activation of the home's CO alarm prompted the homeowner to call 911. No one in any of these homes reported having any CO poisoning symptoms.

Of the 66 homes known to involve a portable generator, 70% (46 homes) called 911 because their CO alarm activated. At 4 of these homes, one or more residents felt ill with one or more CO poisoning symptoms. For the 30% (20 homes) that did not mention a CO alarm activation, there were 3 homes where residents felt ill with one or more CO poisoning symptoms. At one of these, an ambulance assessed the residents, but they declined any further treatment. At another, one person was transported by ambulance to the hospital; from staff's contact with someone at the home, staff learned this person was hospitalized overnight. At a third address, 9 people were transported by ambulances to the hospital; staff was unable to contact anyone at the home to learn further about their status. Residents at 8 of the 66 homes reported that their generators were purchased new in 2021; five of those were bought within days before or after Hurricane Ida made landfall. Two of these were reported to have a CO shutoff feature; the generators were outside and the residents became aware of CO in the house due to their CO alarm activating. In one incident in which the consumer had the newly purchased generator on the pavement next to the house that had an open upstairs window, the consumer stated that that the CO alarm activated immediately after starting the generator.

For the incidents in which the fire department report was provided to staff, staff determined that the fire department was on scene for an average of approximately 30 minutes. When details were provided either in the fire department report or by the consumer, the actions the fire department typically included evacuating residents out of the house; turning the generator off; taking readings with their gas meter to measure CO concentrations throughout the house's living spaces and attic; opening windows and doors when not already done by the residents and ventilating the house with fan(s) (a few fire departments naturally ventilated only) to remove the CO; taking readings to check for CO again before allowing the residents back in the house; asking the residents if they felt ill with any CO poisoning symptoms and assessing them as needed; offering care from or transport by an ambulance; and providing generator safety advice.

When recorded by the fire departments, CO concentrations in the homes that had a portable generator were as high as 100 parts per million by volume (ppmv).[7] For homes in which it was documented how the generator exhaust came in the house, most reported that the generator exhaust came into the house through vents in the attic.[8] Locations where the portable

[7] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

[8] For 23 out of the 63 homes, the fire department documented or the consumer told a CPSC investigator how the exhaust entered into the house.:15 of these homes had the exhaust enter the house through vents into the attic (soffit vents in the eaves, a gable vent, or a ridge vent) and the other 8 homes had it enter through a door, window, or around a window air conditioning unit.

generators were operating ranged from next to the house to 25 to 30 feet away.[9] Several residents stated they chose their covered backyard patio or carport because they thought this location was well ventilated and kept the generator dry. At least three fire department reports stated that the CO exposure at the home where the CO alarm activated was caused by the neighbor's generator.

Of the 87 homes in which the documentation did not specifically indicate that the incident involved a stationary or portable generator, 39% (34 homes) called 911 because their CO alarm activated. Of these, there was one home in which everyone was feeling ill with CO poisoning symptoms of dizziness and headaches. Among the other 61% (53 homes), there were 7 homes that had one or more residents who felt ill with one or more CO poisoning symptoms. An incoherent resident at one of these homes, where the fire department measured 100 ppmv, was taken outside the house, but refused aid from the ambulance. At 3 homes, a total of 8 residents were transported by ambulances to the hospital. Since staff was unable to reach residents at these homes, it is unknown what their treatment was or if any were hospitalized.

In addition to the incidents described above, there was a tragic incident that resulted in the CO poisoning deaths of a 54-year-old woman, her 23-year-old daughter, and 17-year-old son from a newly purchased portable generator.[10] The generator was located outside on the pavement next to the side of their house, under the eaves and about 5 feet from an approximately 6-foot tall fence that runs the length of the property line with their next-door neighbor. The emergency officials noted that all windows and doors on the residence were closed and they had to force entry through a door to get inside. The generator was certified to the Portable Generator Manufacturers Association's (PGMA) U.S. voluntary standard for portable generators, ANSI/PGMA G300-2018. This standard requires the generator to shut off before the CO concentration measured at a location 1 to 2 inches above the approximate center of the portable generator during compliance testing exceeds either a rolling 10-minute average of 400 ppmv or an instantaneous reading of 800 ppmv.[11,12] The generator ran until the gas tank was empty.

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[9] In one incident, the consumer stated that the portable generator was outside her neighbor's house, about 25 to 30 feet from her master bedroom and caused her home's CO alarm to activate. The consumer did not have a generator and had the windows to her house opened to alleviate the heat since outdoor temperatures were in the 90s. After the neighbor refused to discontinue use of the portable generator, the fire department advised the consumer to close the window to their master bedroom and to open all other windows to ventilate the house. (One fire department report noted that arguments between neighbors due to generators "is the scene of many repeat calls".) In another incident, the generator was in the backyard approximately 25 feet from the house in an open area.

[10] Redacted IDI in Document ID number CPSC-2006-0057-0110 in CPSC's docket CPSC-2006-0057 in www.regulations.gov

[11] *ANSI/PGMA G300-2018 (Errata Update), Safety and Performance of Portable Generators*, available online at https://www.pgmaonline.com/pdf/ANSI_PGMAG300-2018(ErrataUpdateApril2020).pdf.

[12] To provide a frame of reference for the CO concentrations required for shutoff, staff provides here the CO concentrations that are required in UL 2034 (the U.S. voluntary standard for residential CO alarms) for alarm activation to alert occupants of dangerous CO concentrations. They are as follows: the alarm shall be active for 70 ppmv CO between 60 to 240 min, 150 ppmv CO between10 min to 50 min, and 400 ppmv CO between 4 to 15 min. In each of these, the CO alarm must activate before the upper time limit is reached and must not activate before the lower time limit is reached. The upper time limit of these activation points is based on 10% COHb, which is the level at which one might begin to experience the onset of mild symptoms, such as a headache. For a correlation between COHb and exposure to a CO concentration for a given time duration, see Figure 41.1 in UL 2034, which is available for free digital viewing at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=32610. (It is important to note that the relationship between CO concentration and COHb is non-linear. This means that, for example, after a

Using a CO meter, the fire department measured CO at concentrations of 684 ppmv inside the house and 200 ppmv outside where the generator was located.

IV. Discussion

One finding from the review of the hurricane Ida incidents is that the CO alarms helped prevent injuries and likely saved lives in the incidents with homes that had working CO alarms and likely could have also helped in the incidents where homes did not have working CO alarms. This supports CPSC's recommendation that every home should have one or more CO alarms.[13] Staff also concludes that this demonstrates that CO alarms, while they can be lifesaving devices, should be considered the *last* line of defense. The first line of defense should be generators that produce less CO to minimize the risk of enabling dangerous concentrations of CO to build up in the home in the first place.

Staff determined that the fire department was on scene for an average of approximately 30 minutes in response to these incidents, thus incidents like these, which could be addressed by the draft proposed rule, take up valuable fire department resources as well.

Another finding is that there were incidents in which the portable generator was operated at distances as great as 25 to 30 feet from the home when information on the distance was provided, yet enough CO came indoors to activate the home's, or the neighbor's home's, CO alarm. It is important to note that the CO emission rates of almost all portable generators are extremely high, on the order of *hundreds or* greater times the CO emission rates of cars.[14] Because CO alarm use and maintenance is not universal, consumers of current portable generators are required to position these products to prevent CO infiltration into not only their own homes, but into the homes of nearby neighbors. This also means that consumers who do not own or intend to operate a portable generator would still be required to have a functioning CO alarm to warn themselves if a CO exposure is occurring from *others'* portable generator use. Performance requirements that reduce CO emissions at the source address these issues.

CO exposure profile has reached a peak and is decreasing, the COHb will continue to rise for some time before COHb decreases. This is exemplified in test results presented in NIST Technical Note 2049 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Portable Generators with a CO Safety Shutoff Operating in a Test House*, available online at https://doi.org/10.6028/NIST.TN.2049. In the vast majority of the tests, the peak COHb levels were attained hours after the generator shut off.)

[13] More specifically, CPSC recommends every home have battery-operated CO alarms or CO alarms with battery backup on each level and outside separate sleeping areas. Furthermore, CPSC recommends that the CO alarms be interconnected so that when one activates, they all activate.

[14] The comparison depends on the size of the generator, the load on the generator, and the fuel efficiency of the car used for the comparison. A mid-size generator powering a moderate number of appliances emits approximately 1570 grams per hour (g/h) of CO and a large generator emits approximately 3030 g/h (see table 4 in *CPSC Staff Briefing Package on Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard, and Information on Availability of Compliant Portable Generators*, February 16, 2022 https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 (Document ID CPSC-2006-0057-0107 in CPSC's docket CPSC-2006-0057 in www.regulations.gov). Published emission rates of idling cars from the 1990's show that they emit approximately 2 to 5 grams per hour. (see Frey, H., et al., *On-Road Measurement of Vehicle Tailpipe Emissions Using a Portable Instrument*, Journal of the Air & Waste Management Association, Vol.53, August 2003.) Using these emission rates, the comparison equates to generators emitting hundreds to thousands of times more CO than the 1990's cars. Generators delivering a higher load emit more CO and today's more fuel-efficient cars emit less CO.

Finally, the people who experienced mild CO poisoning symptoms called 911, which supports the conclusion that slow onset of symptoms affords people the opportunity to take actions for self-rescue.[15] A call to 911 was not placed from any of the three people who died from the generator running outside their home and the details provided in the responding officials' report suggest they did not have slow onset of symptoms.

V. Conclusion

Staff concludes that the findings from this case study support a requirements in staff's draft proposed rule that specifies a limit on the portable generator's CO emission rate as well as the lower CO shutoff threshold in the draft proposed rule. The proposed criterion, which is based on the requirements in Underwriters Laboratories' (UL) U.S. voluntary standard for portable generators, UL 2201, is a maximum weighted[16] CO emission rate of 150 grams per hour (g/h) and a shutoff threshold of not to exceed 400 ppmv or a 10-minute rolling average of 150 ppmv, measured 1 foot above the generator's top surface during compliance testing. Staff estimates this CO emission rate represents a reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule. Reducing the CO emission rate to this level will correspondingly reduce the amount of CO coming inside and consequently reduce the risk of injury or death.

Staff recommends that the Commission seek information about CO exposures, CO injuries, and CO alarm activations that have occurred from portable generators operating outdoors as well as indoors.

[15] Staff has assessed that consumers exposed to the high CO emission rates of almost all current generators can experience sudden, steep rise of carboxyhemoglobin (COHb) levels, leading them to experience a rapid onset of confusion, loss of muscular coordination and loss of consciousness. This can occur so suddenly that they do not experience the milder CO poisoning symptoms associated with a low, or slowly rising, CO level that affords them the opportunity to recognize a hazardous situation is developing and take action that will save themselves from further injury or death.

[16] The weighted CO emission rate is calculated from the emission rates that are measured while each of 6 different prescribed loads are applied to either the engine or the generator (depending on which of the two the test methods in the draft proposed rule is used) and multiplying each emission rate with a prescribed weight factor and then summing the product of weight factor and emission rate for each of the six loads.

TAB E: Draft Proposed Rule for Portable Generators: Scope, Description of the CO Emission and CO shutoff Requirements, and their Rationale

United States
Consumer Product Safety Commission
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MEMORANDUM

TO: To File

DATE: January 28, 2023

THROUGH: Caroleene Paul, Director
Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

Michael Nelson, Director
Division of Mechanical Engineering
Directorate for Laboratory Sciences

FROM: Janet Buyer
Division of Mechanical and Combustion Engineering

Matthew Brookman
Division of Mechanical Engineering

SUBJECT: Draft Proposed Rule for Portable Generators: Scope, Description of the CO Emission and CO shutoff Requirements, and their Rationale

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I. Background

This memorandum describes and provides rationale for staff's recommendations for the scope and CO emission rate and CO shutoff requirements of the draft proposed rule.[1] The draft proposed rule incorporates sections of UL 2201, *Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators, Second Edition* [2] (UL 2201) and ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators.*[3,4] (PGMA G300), with modifications to ensure the effectiveness of the draft proposed requirements. A general description of each voluntary standard is provided below.

[1] A description and rationale for the notification and labeling requirements of the draft proposed rule are in TAB F of this briefing package.

[2] *UL 2201, Standard for Safety for Carbon Monoxide (CO) Emission Rate of Portable Generators*, *Second Edition*, Dated January 9, 2018. UL 2201 is available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=33821

[3] *ANSI/PGMA G300-2018 (Errata Update), Safety and Performance of Portable Generators*, available online at https://www.pgmaonline.com/pdf/ANSI_PGMAG300-2018(ErrataUpdateApril2020).pdf

[4] On May 1, 2020, PGMA issued an erratum update to ANSI/PGMA G300-2018 that changed the requirement for packaging marking from a logo to the following text or equivalent wording: "This product complies with the ANSI/PGMA G300-2018 standard."

A. UL 2201

UL 2201, published on January 9, 2018, applies to "spark-ignited engines installed in portable generators for each fuel type recommended by the manufacturer." It includes a requirement for a maximum weighted[5] CO emission rate of 150 grams per hour (g/h). It also includes CO concentration based shutoff requirements. When the CO concentration is measured above the generator during compliance testing, the generator must shut off either:

1. before exceeding 150 parts per million by volume (ppmv) of CO for a 10-minute rolling average or,
2. when an instantaneous reading of 400 ppmv is measured.[6]

The standard provides the option of using one of two test procedures for verifying the CO emission rate: (1) testing with the engine installed in the generator assembly, in the configuration when the consumer purchases it; or (2) by testing the standalone engine in accordance with the EPA's engine emission test procedure defined in Engine Testing Procedures, 40 CFR part 1065. The UL standard also provides a test method for verifying the shutoff criteria. UL 2201 has no effective date, which means that any product certified to UL 2201 after publication of the 2nd Edition on January 9, 2018, must meet the requirements of the 2nd Edition.

B. PGMA G300

PGMA G300, published on April 20, 2018, includes a requirement for generators to be equipped with an onboard CO sensor that is certified to requirements in the latest edition of ANSI-Approved *UL 2034 Standard for Safety for Single and Multiple Station Carbon Monoxide Alarms*. PGMA G300 does not limit the CO emission rate. The generator must shut off before the CO concentration, measured 1 to 2 inches above the approximate center of the portable generator's top surface, exceeds either:

1. a 10-minute rolling average of 400 ppmv or,
2. an instantaneous reading of 800 ppmv.

As described in TAB F of this briefing package, PGMA G300 requires notification after a shutoff event. This notification is required to be "a red indication," but the type of indicator is not specified (*e.g.*, the indication is not required to be a light). The standard allows, but does not require, the indication to be "blinking, with a maximum period of 2 seconds." The indication must remain for a minimum of 5 minutes after shutoff occurs unless the generator is restarted. The standard also includes requirements for: (1) a label about the automatic shutoff that must be located near the notification indicator and instructs the consumer to move the generator to an outdoor area and seek medical help if feeling sick; (2) a marking on the generator to show the location of the exhaust; (3) a self-monitoring system; (4) maintaining the system's functionality, including tamper resistance; and (5) the system's CO sensor.

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[5] The weighted CO emission rate is calculated from the emission rates that are measured while each of 6 different prescribed loads are applied to either the engine or the generator (depending on which of the two the test methods in the draft proposed rule is used) and multiplying each emission rate with a prescribed weight factor and then summing the product of weight factor and emission rate for each of the six loads

[6] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

The scope of PGMA G300 is:

> 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.

PGMA G300 has an effective date of March 31, 2020, which means that if a manufacturer certified a generator to PGMA G300 after that date, it must be certified to the 2018 edition and not to the prior 2015 edition.

II. Scope of the Draft Proposed Rule

Staff recommends that the draft proposed rule apply to single phase[7], 300 V or lower, 60-hertz generators that are provided with receptacle outlets for the AC output circuits and intended to be moved by the consumer, though not necessarily with wheels. The engines in these "portable" generators are nonroad small spark ignition (SI) engines[8], based on the U.S. Environmental Protection Agency's (EPA) engine classifications per 40 C.F.R. § 1054.801, and are fueled by gasoline, liquefied petroleum gas (LPG), or natural gas (NG). In the 2016 NPR, the scope of the proposed rule divided generators into different categories depending on the size of the generator's engine and the proposed rule applied different emission rate limits depending on the different-sized engines. The scope of this draft proposed rule does not divide the generators into different categories. Neither voluntary standard separates the generators into different categories, and requirements in the voluntary standards apply equally to all portable generators. Similarly, there is no longer a reason to separate portable generators into different categories based on staff's recommended requirements, and the requirements would thus apply equally to all portable generators.

Staff recommends excluding the following generators from the scope of the draft proposed rule:

- *Permanent stationary generators*: excluded because they have installations and use patterns that differ from portable generators. They are installed in a fixed location outside the home with permanent electrical and fuel (NG or LPG) connections that minimize

[7] Residential wiring systems typically consist of a single-phase power supply with two line conductors and a neutral conductor such that each line conductor is at a potential of 120 V to neutral, and the two lines are at a potential of 240 V. The draft rule excludes three-phase generators, which are rarely used in residences, but are widely used in commercial and industrial applications where power demands are higher; a three-phase generator output includes three line conductors.

[8] These are engines used for lawn and garden equipment and other small outdoor power equipment and tools. Spark-ignition means that a spark ignites the air-fuel mixture in the engine's cylinder to initiate the combustion process. The combustion process converts the latent energy of the fuel into mechanical power when the explosion of the fuel-air mixture pushes the piston down in the cylinder which in turn rotates the engine's crankshaft.

consumer interaction with the product. In addition, they are covered by different safety standards.[9]

- *50-hertz (Hz) generators*: excluded because 50-Hz power systems are not used in the United States.
- *Marine generators and generators permanently mounted in recreational vehicles or motor homes*: excluded because, even though these models may be the similar to those falling within the scope of this draft proposed rule, they generally are outside CPSC's jurisdiction under the Consumer Product Safety Act (CPSA).
- *Generators solely intended to be pulled by, or mounted on, vehicles*: excluded because CPSC staff is not aware of any CO incidents in our databases involving these generators. Furthermore, these generators are primarily work-related and are not typically consumer products.
- *Generators with compression ignition (CI) (i.e., diesel) engines*: excluded because CPSC staff is not able to confirm any fatality as involving a diesel generator. Diesel engines emit significantly less CO than SI engines. Furthermore, portable diesel generators are primarily used by individuals in a work-related setting or environment, and typically are notwithin CPSC's jurisdiction.
- *Industrial-type generators intended solely for connection to a temporary circuit breaker panel at a jobsite, and not for consumer use*. Staff is not aware of any CO incidents involving this type of generator.

The scope of the draft proposed rule is mostly in line with the scope of PGMA G300. However, although PGMA G300 excludes generators in engine driven welding power sources from the scope of its standard, staff recommends including these generators in the scope of the draft proposed rule. Staff considers these generators to be consumer products; they are readily available for consumer purchase, and CPSC databases have records of at least 8 deaths from 5 incidents in the years 2004 through 2021 in which it was reported that the machine was being used as generator. Also, staff's recommended scope does not put an upper limit on the kilowatt rating of portable generators because portable generators with rated power above 15 kW are a consumer product and are readily available for consumer purchase.

III. Requirements of the Draft Proposed Rule and their Rationale

The draft proposed rule requires in-scope portable generators to emit no more than a weighted CO rate of 150 g/h of CO and to automatically shut down before specific CO concentration requirements are exceeded above the generator. Additional requirements address the durability, reliability, and functionality of the shutoff system as well as notification and labeling for the shutoff system. The requirements of the draft proposed rule incorporate requirements from UL 2201 and PGMA G300, with some modifications to ensure the effectiveness of the draft proposed requirements. The draft proposed rule's requirements, along with the rationale for

[9] The applicable product safety standard for stationary generators is ANSI/CAN/UL/ULC 2200 - *Stationary Engine Generator Assemblies*. Consumers generally do not self-install residential stationary generators. Installers would need to comply with the manufacturer's instructions and the applicable codes (likely NFPA 70 – *National Electrical Code* (*NEC*), and NFPA 37 - *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*) being enforced by the local authority having jurisdiction in accordance with local or state ordinances.

each, are provided below with exception for the notification and labeling requirements; those are in TAB F of this briefing package. A summary description of the requirements is in Tab H.

A. CO Emission Rate and Shutoff Criteria

In UL 2201, Section 5.2.8 and Section 5.3.3 specify that the calculated weighted CO emission rate of a generator should not exceed 150 g/h, using the formula specified in sections 5.2.2 and 5.3.2 of UL 2201, respectively. Section 6.5.2 and 6.5.3 of UL 2201 provide pass/fail criteria for shutting off the portable generator based on a measurement taken above the generator during compliance testing. The generator must shut off when a 400 ppmv instantaneous measurement is achieved or before exceeding a 10-minute rolling average of 150 ppmv. In PGMA G300, section 6.2.11.1 provides a requirement that a portable generator engine must shut off before the CO concentration exceeds 800 ppmv or a 10-minute rolling average of 400 ppmv, measured above the generator during compliance testing. Section 6.2.11.2 of PGMA G300 provides the test procedure.

Staff's effectiveness analysis of each voluntary standard's performance requirements shows that UL 2201's CO emission rate requirement of 150 g/h, combined with UL 2201's shutoff concentration requirements adequately addresses the CO hazard when coupled with durability, tamper-resistance and other requirements. This is because the results of the analysis, described here, showed these requirements resulted in no deaths and relatively few injuries. To evaluate the effectiveness of these requirements, along with the shutoff requirements in PGMA G300, CPSC staff worked with staff of the National Institute for Standards and Technology (NIST) to simulate the scenarios of 511 fatalities in CPSC's databases using an indoor air quality (IAQ) modeling program.[10] Staff's briefing package, "Assessment of Portable Generator Voluntary Standards' Effectiveness in Addressing CO Hazard,"[11] describes the simulations and analysis in detail. What follows is a summary of the simulations.

CONTAM simulated a 24-hour period during which a noncompliant generator, referred to as a "baseline generator," emitted CO at a specified rate, representing a baseline generator, at a specified location inside a house, for a specified number of hours, which represented the generator's run time associated with that CO emission rate on a full tank of fuel. CONTAM simulated the accumulation and transport of CO throughout the house while the generator was emitting CO, and the continued transport of CO for the remainder of the 24-hour period after the generator ran out of fuel. For each of the voluntary standard-compliant generators, CONTAM also simulated a 24-hour period that started with the generator operating in the same location inside the house as the baseline generator, emitting CO at a specified rate, representative of a voluntary standard-compliant generator. However, if the CO concentration in that location reached the voluntary standard's criteria for shutting off the generator, the CO emission stopped. The simulation then continued in one of a variety of ways for the remainder of the 24-

[10] The modeling program, called "CONTAM," (not an acronym) is a multizone airflow and contaminant transport indoor air quality (IAQ) modeling program that was developed by NIST and has been used for several decades. It models the buildup and transport of contaminants within, into, and out of a building. A range of validation studies have demonstrated its ability to predict reliably building air change rates and contaminant levels.

[11] February 16, 2022. https://www.cpsc.gov/s3fs-public/Briefing-Package-on-Portable-Generator-Voluntary-Standards.pdf?VersionId=hLnAkKQ6bCD_SKin8RE6Iax.BjZsB5x3 document Id number CPSC-2006-0057-0107 in www. Regulations.gov.

hour period, *i.e.*, with the generator either not restarted, or restarted 10 minutes later in the same location, or in a new location, that was either indoors or outdoors, with window and door positions changed. If the generator was restarted indoors and it stopped again, it was restarted a second time outdoors. In every simulation in which the generator was restarted, the voluntary standard-compliant generator operated until the full fuel tank was empty, just as the baseline generator operated. Every simulation yielded CO concentrations in each room of the house as a function of time over the 24-hour analysis interval. These concentrations were then used to calculate carboxyhemoglobin (COHb) levels for the house's theoretical occupants. The COHb level serves as a useful measure of expected CO poisoning severity. Comparing the occupants' health effects from the simulation of a baseline generator to a voluntary standard-compliant generator provides staff's assessment of the benefits offered by the compliant generators for deaths averted and level of injury, if any, the survivors sustained. Staff completed approximately 140,000 simulations for 37 different house models and three detached garages, with various generator locations and generator sizes in 28 different weather conditions.

Staff's analysis of the simulation results found that under simulated conditions, generators compliant with the CO emission rate and shutoff requirements of the UL 2201 standard would avert nearly all 511 deaths, or nearly 100% of the deaths, with three survivors requiring hospitalization, and 24 survivors seeking medical treatment and being released. Staff's analysis found that generators compliant with the shutoff requirements of the PGMA G300 standard would avert about 87% of the 511 deaths, resulting in 69 deaths, with 54 survivors requiring hospitalization, and 88 survivors seeking medical treatment and being released.[12]

Staff recommends that the draft rule incorporate UL 2201's CO emission rate requirement specified in section 5.2.8 or 5.3.3. Staff also recommends that the draft proposed rule incorporates the CO shutoff concentrations of 400 ppmv instantaneous and 150 ppmv over a 10-minute rolling average from UL 2201. Both section 5.2.8 and 5.3.3 of UL 2201 specify the 150 g/h CO emission rate requirement, which is arrived at using one of two test methods, specified in sections 5.2 and 5.3 and described further in section 3.2. The manufacturer may choose which test method to use. Staff's analysis of the simulations performed by NIST shows that these requirements in UL 2201 prevented all deaths and resulted in the survivors sustaining relatively few injuries. The requirements in PGMA G300, which resulted in deaths and more injuries that UL 2201, does not adequately address the CO hazard.

B. Test Method for Verifying Compliance with CO Emission Rate Requirement

The draft proposed rule includes either of two test methods provided in section 5 of UL 2201 as the requirements to verify compliance with the CO emission rate. Test option 1 provides requirements for measuring the CO emission rate of the portable generator assembly, which means the configuration of the generator when the consumer purchases it. Test option 2 provides requirements for measuring the CO emission rate of just the engine, not as part of the generator assembly but rather while mounted on a dynamometer. (A dynamometer is a device for applying a precise load on the engine, in this case to mimic the appliances and tools

[12] See TAB A of this briefing package. These are updated results after staff found a tabulation error in the analysis of the simulation results after publication of the reference listed in footnote 11 of this memorandum.

consumers would plug into the generator for power.) Either test method is acceptable because the first method measures the emissions a consumer would be exposed to when using the generator and the second method provides a more conservative measurement but one that the U.S. Environmental Protection Agency (EPA) requires, per their engine emission test procedure defined in Engine Testing Procedures, 40 CFR part 1065.[13]

In the first option for the test methods, the loads to be applied to the generator are based on the maximum available observed wattage, which is the same as rated wattage as determined in Section 6.3.2 of PGMA G300.

C. Test Method for Verifying Compliance with CO Shut-Off Criteria

The draft proposed rule includes requirements for a standardized test method to verify compliance with the CO shutoff criteria. An effective test method must expose the CO safety shutoff system to CO concentrations that will initiate shutoff. The test method also must verify that the CO safety shutoff system functions properly or does not allow the generator to start when the power supply to the system is not functioning. Staff assesses that the test method in PGMA G300 provides a reasonable foundation for a test method to reliably assess the safety shutoff system.

UL 2201 and PGMA G300 provide similar test methods for evaluating the performance of the CO safety shutoff system to a set of acceptance criteria. Both test the generator assembly in an enclosed space that is filled with exhaust emissions from the generator while an air sample is taken from above the generator to determine if the generator shuts off before the room reaches the shutoff acceptance criteria.

The CO safety shutoff system test method in Section 6 of UL 2201, Generator Assembly Enclosed Space Testing, requires three separate tests with different temperatures, ventilation in units of air change per hour (ACH), and loads to verify compliance with the CO shutoff criteria. Specifically, these three test conditions are as follows:

- Test 1: Cold condition -10 ±5°C (30.2 ±9°F), no ventilation 0 ACH, high load 100 percent
- Test 2: Warm condition 30 ±5°C (86 ±9°F), high ventilation 5 ±0.5 ACH, medium load 50 percent
- Test 3: Warm condition 30 ±5°C (86 ±9°F), high ventilation 5 ±0.5 ACH, low load 10 percent

Ventilation rate and load only affect the time it will take for CO to accumulate in the test room. Additionally, if the CO sensor and circuit are designed to the specifications in UL 2034, Edition 4, the temperature range in the tests specified in UL 2201 will not affect the performance of the CO safety shutoff system. Given the ranges for ventilation rate and load required in the UL tests, it is possible that the CO concentration may not exceed the shutoff concentration requirement in some test scenarios. For instance, if a small generator meeting the emissions

[13] The Clean Air Act requires EPA to establish national ambient air quality standards for certain common and widespread pollutants to address air pollution. Under the Clean Air Act, EPA sets emission standards for engines of all sizes, including those used in portable generators, to address air pollution. To show compliance with these emission standards, engine manufacturers must follow test procedures specified in 40 CFR part 1065

requirement in section 3.1 of this document is operating at a low load such as 10 percent of the maximum available observed wattage (defined as rated wattage per the PGMA G300 test method referred to in UL 2201) required in Section 6.4 of UL 2201 for test 3, documented above, it will likely emit a very low level of CO. This condition combined with a high ventilation rate could result in the CO concentration in the room never exceeding the shutoff criteria. If this were to occur, the generator would operate until the fuel supply is depleted or the generator shuts down due to overheating. However, the CO shutoff system may not, nor should it be expected to, shut the generator off if the test does not expose the shutoff system to the full range of CO concentrations allowed by the shutoff criteria. There is no provision in the UL test method that addresses this circumstance, such as by repeating the test at a lower ventilation rate so the CO concentration can build up in the test room to sufficiently test the CO safety shutoff system. Without a provision for this, the UL test method is unable to provide a result to determine compliance to a shutoff requirement. The potential exists where the test method will fail to verify shutoff performance, thus staff finds this test method inadequate for assessing shutoff performance.

Section 6.2.11.2 of PGMA G300 provides the test method for evaluating the CO safety shutoff system to concentration shutoff criteria. Section 6.2.11.2 requires an initial test room temperature of 15-35 ºC (59-95 ºF), a ventilation rate of 0 to 1 ACH, and a load between 42 and 52 percent of the rated wattage. The ventilation requirements for this test are much lower than two of the tests in UL 2201, making it less likely that a generator could operate until it is out of fuel before the room achieves a CO concentration in excess of a shutoff concentration requirement. Additionally, and most importantly, if a generator were to operate until it ran out of fuel, the low ventilation rate and flexibility in how this requirement is written allow for the test to be repeated at a reduced ventilation rate.

PGMA G300 also requires that the battery, capacitor, or other energy storage device used to supply power to the CO safety shutoff system be discharged or removed at the beginning of the test to evaluate the performance of the system when this power supply is compromised. UL 2201 does not require this step and therefore does not evaluate if the CO safety shutoff system will still operate properly or prevent the generator from starting if the power supply for the CO safety shutoff system is compromised. Staff considers a CO safety shutoff system to be effective if it shuts the generator off before room CO concentrations exceed the acceptance criteria, even with a compromised power supply, or it does not allow the generator to start when the shutoff system is inoperable. In the PGMA G300 test method, a generator that will not start under these conditions is tested again with the energy storage device installed and operable. If it does not start with the power supply compromised, it fails safe, but it is still important to determine if the shutoff system will function appropriately with the power supply properly charged and/or intact.

CPSC staff concludes that the test method in Section 6.2.11.2 of PGMA G300 and related terminology defined in Section 2 of PGMA G300 are generally appropriate to evaluate the CO safety shutoff system specified in Section 3.1 of this document.[14] Staff, however, recommends some changes to the PGMA test method and definitions in Section 2 that will better assess the

[14] Related terminology in Section 2 of PGMA G300 includes air change rate, CO analyzer, engine, portable generator, portable generator system for controlling CO exposure, rated wattage, and test room with changes specified in this document.

CO safety shutoff system and therefore further reduce the risk of death and injury associated with portable generator CO poisoning. Specifically, CPSC staff recommends that the test method be modified as follows:

Test Room Volume and Dimensions: CPSC staff determined that it is not necessary for the room volume to be constrained to the volumes identified in PGMA G300 or UL 2201. Staff assesses that an increase in the range of acceptable room volumes to 895 – 2100 ft^3 (25.34 – 59.47 m^3) to accommodate a wider range of existing rooms within various test facilities will not affect the outcome of the tests. There are generators on the market that currently certify to UL 2201 and PGMA G300, therefore testing has been performed using both ranges of test room volumes specified in each standard. Increasing the range to 895 – 2100 ft^3 (25.34 – 59.47 m^3) encompasses the ranges specified in both standards. Accordingly, the draft proposed rule specifies that the test room shall be designed such that the room volume is between 895 – 2100 ft^3 (25.34 – 59.47 m^3) with a ceiling height between 8 -12 ft (2.44 - 3.66 m) and be capable of meeting the requirements for generator position.

Test Room Air Inlet and Outlet Specifications: PGMA G300's test method does not specify the location and dimensions of the air inlet and outlet. Staff assesses that specifying the location and dimensions of the air inlet and outlet is necessary because the air flow near the inlet and outlet could affect CO concentrations near the onboard sensor or the sample port for the CO analyzer. Accordingly, the draft proposed rule defines the location of the air inlet and outlet by specifying their configuration based on performance. Specifically, the draft proposed rule requires that the configuration of the air inlet and outlet for ventilation be designed such that neither port creates a flow directly onto or near the CO analyzer sample port above the generator or the CO sensor onboard the generator that is used as part of the CO safety shutoff system.

Ventilation: PGMA G300 does not specify a requirement for how ventilation is induced. Requiring a fan on the air outlet will ensure that the ventilation system will not create a positive pressure within the room. A scenario with no ventilation, or 0 ACH, induced by an air inlet fan can pose a safety risk to test operators because the pressure in the room may exceed the pressure outside of the room as the generator heats the space. This could result in leakage from the test room. Specifying a minimum of 0.1 ACH will create a slightly negative pressure in the room, which will assist in preventing leakage. Accordingly, staff recommends changing the ventilation range to 0.1 – 1.0 ACH to reduce the potential of gas leakage from the test room. Additionally, staff recommends requiring an exhaust fan on the air outlet to induce ventilation from the room and that no air inlet fan can be used. The draft proposed rule requires that the ventilation rate of the test room shall be between 0.1 – 1.0 ACH and ventilation shall be induced by a fan on the air outlet.

Generator Position within the Room: Staff assesses that it is necessary to provide constraints on the position of the generator to accommodate different test room dimensions. These constraints address concerns related to airflow around the CO sensor onboard the generator and CO analyzer sampling port, as well as, exhaust gas diffusion within the space. Accordingly, the draft proposed rule requires that the generator be positioned such that the exhaust jet centerline is along one of the test room centerlines; the exhaust outlet on the generator is at least 6 ft (1.83 m) from the opposite wall; the outer surfaces of the generator

housing or frame are at least 3 ft (0.91 m) from the walls on all other sides; and the onboard CO sensor used for the CO safety shutoff system is at least 1 ft (0.30 m) away from any obstruction.

CO Measurement Location: PGMA G300 specifies that the CO sample port, which is used in conjunction with the CO analyzer to measure the concentration of CO above the generator, be placed 1 to 2 inches above the approximate center of the generator's top surface. CPSC staff believes that this location is too close to the generator and the sample may be affected by low flow/mixing conditions present near the surfaces of the generator. Accordingly, staff recommends an increase to the height of the CO sample port above the generator. The draft proposed rule requires that the CO sample port connected to the CO analyzer for determining room concentration shall be placed 1 ft (0.30 m) above the center point of the top of the generator.

Load Bank and Power Meter Specifications: The load bank is used to apply an electrical load on the generator. Applying an electrical load to the generator will simulate the conditions of a generator under typical use. PGMA G300 specifies a range of requirements for a voltmeter, wattmeter, ammeter, frequency sensor, and load bank. These requirements include tolerances for measurement of true root mean square (RMS) voltage, wattage, and current. CPSC staff believe that these requirements are unnecessary as an exact load or associated emission rate is not required to test the CO safety shutoff system. For the proposed test requirements, CPSC staff recommends that the load bank shall be of a resistive type and be capable of adjustment to within 5 percent of the required load range. Staff recommends that the power meter be capable of measuring electrical loads to within 5 percent. Therefore, a resistive load bank and power meter with an accuracy of 5 percent is sufficient to achieve the goals of testing.

D. Maintaining Functionality of the CO Shutoff System

The analysis assessing the effectiveness of the performance requirements in the voluntary standards assumed the shutoff system functioned properly and shut the generator off when the shutoff criteria in each voluntary standard were met. If the shutoff system is bypassed, damaged, or overridden such that the generator can operate without the shutoff system functioning, or functioning properly, the effectiveness of the performance requirements would be reduced. Thus, requirements to maintain the functionality of the shutoff system are necessary in the draft proposed rule.

PGMA G300 has requirements regarding tamper resistance in sections 3.9.1.2.1. through 3.9.1.2.4. Specifically, section 3.9.1.2.1 requires that the portable generator system for controlling exposure be tamper resistant and specifies when a system is considered tamper resistant. According to Section 3.9.1.2.1, the system is considered tamper resistant when all parts that affect the proper operation of the portable generator system for controlling CO exposures meet at least one of the following: (1) the part is permanently sealed; (2) the part is not normally accessible by hand or with ordinary tools; or (3) removal or disconnection of the part prevents the engine from running. Section 3.9.1.2.1 allows for different parts of the portable generator system for controlling exposure to meet the requirement for tamper resistance using any of the options, provided all of the different parts meet at least one of the options. Staff concludes that the requirements in section 3.9.1.2.1. are inadequate because the requirements do not preclude that the generator can operate or continue to operate when the CO sensor is bypassed in the circuitry. For example, permanently sealing a part of the CO

system would meet the standard's requirements, even if the part could be bypassed without preventing operation of the generator. Accordingly, the draft proposed rule includes that removal or disconnection of the part prevents the engine from running is mandatory, rather than being an optional means to achieve tamper resistance. Furthermore, the draft proposed rule includes an additional requirement that states shorting any part that disables the operation of the system shall prevent the engine from running.

Section 3.9.1.2.2 of PGMA G300 requires that construction of the portable generator minimize the risk of intentional blockage of the gas inlet of the portable generator system for controlling CO exposure. Section 3.9.1.2.3 provides that the construction of the portable generator shall minimize the risk of incidental damage to the portable generator system for controlling CO exposure. Section 3.9.1.2.4 provides that the portable generator system for controlling CO exposure shall not incorporate any type of override function or feature. Staff concludes that these requirements are necessary and adequate to ensure the CO shutoff system maintain functionality.

E. Self-Monitoring of CO Shutoff System

The effectiveness analysis assumed the shutoff system functioned properly and shut the generator off within the bounds of the shutoff criteria in each voluntary standard. If the system has a fault, loss of power, or the system reaches end-of-life yet the generator operates without the shutoff system functioning, the effectiveness will be reduced. Therefore, staff assesses that requirements for self-monitoring of the shut off system are necessary. PGMA G300 provides requirements for self-monitoring while UL 2201 does not. PGMA G300's requirements in section 3.9.1.1 require that faults, indicative of a fault with the CO sensing element, loss of power source for the CO shutoff system, and end of life condition, be applied one at a time to the system's circuitry while the engine is running. The engine is required to shut off after each fault or end of life signal is introduced. Staff concludes that these self-monitoring requirements are necessary for ensuring proper functioning of the shutoff system. Thus, the requirements are included in the draft proposed rule.

F. Durability Requirements of the CO Shutoff System

Staff's effectiveness analysis of the voluntary standards assumes the shutoff system is durable and reliable and always shuts off the generator based on the prescribed CO concentration requirements for each voluntary standard. Durable and reliable operation of the CO shutoff system is critical. The system must be designed to withstand gas and vapor interference, vibration, dust, corrosion, varying temperature and humidity, which are environmental conditions associated with the use, transportation, and storage of portable generators. Section 3.9.1 and 3.9.1.4 of PGMA G300 references requirements in UL 2034, *Single and Multiple Station Carbon Monoxide Alarms,* to address the construction and performance of the CO safety shutoff system.[15] This standard is the leading standard for CO alarms in the United States and provides a robust set of requirements for CO alarms. CO alarms that meet the requirements of UL 2034 have demonstrated reliable operation for many years. UL 2034 provides design and performance requirements for CO alarms that cover topics related to the construction of the CO

[15] Edition Date: March 31, 2017; ANSI approved: October 7, 2022. UL 2034 is available for free digital view at https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=32610

shutoff system such as gas and vapor interference, dust exposure, vibration, corrosion, and extreme temperature and humidity exposure. Additionally, section 3.9.1.4 of PGMA G300 requires that the carbon monoxide sensor used in the shut off system have a UL mark or equivalent Nationally Recognized Testing Laboratory (NRTL) mark. This ensures that the sensor is capable of meeting the requirements for use in UL 2034 compliant systems. Staff concludes that the CO shutoff system must meet appropriate sections of UL 2034 identified in PGMA G300 with any modification necessary to meet the requirements in the draft proposed rule, such as the concentration limits for CO shutoff. UL 2034 should be used as the minimum requirement for the design and performance of the CO shutoff system. UL 2201 on its own is not adequate to address the CO shutoff system because it does not prescribe requirements for the construction of the CO shutoff system. If the system does not function properly because of conditions affecting its durability and ability to reliably shut the generator off when the shutoff criteria are met, the effectiveness will be reduced. Staff concludes that the related construction and performance requirements in section 3.9.1 and 3.9.1.4 of PGMA G300, with the modification that the shutoff criteria need to correspond to those of the draft proposed rule, are necessary to address this critical issue. These requirements address the environmental conditions (gas and vapor interference, dust, vibration, corrosion, and variable temperature and humidity) that the shutoff system could be exposed to when mounted on a portable generator.

G. Notification System and Labeling for the CO Shutoff System

For a discussion of the notification and labeling requirements of the draft proposed rule, see TAB F.

TAB F: Human Factors Recommendations for CO Shutoff Notification Requirements for Portable Generators

United States
Consumer Product Safety Commission
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Memorandum

TO: Janet L. Buyer, Project Manager, Portable Generators Project,
Division of Mechanical and Combustion Engineering,
Directorate for Engineering Sciences

DATE: January 28, 2023

THROUGH: Mark E. Kumagai, Associate Executive Director,
Directorate for Engineering Sciences

Rana Balci-Sinha, Ph.D., Director,
Division of Human Factors, Directorate for Engineering Sciences

FROM: Timothy P. Smith, Senior Human Factors Engineer,
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: Human Factors Recommendations for CO Shutoff Notification Requirements for Portable Generators

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I. Background

In 2016, staff of the U.S. Consumer Product Safety Commission (CPSC) delivered to the Commission a draft proposed rule intended to address the risk of carbon monoxide (CO) poisoning associated with portable generators (Buyer, 2016). As proposed, the rule would have limited the CO emission rates of portable generators, resulting in reductions of about 75 to 90 percent relative to the emission rates of then-current portable generators. The Commission voted to approve publication of the draft proposed rule, and on November 21, 2016, published a notice of proposed rulemaking (NPR) in the *Federal Register* (81 FR 83556).

Section 7 of the Consumer Product Safety Act (CPSA) requires the Commission to rely on an existing voluntary standard, rather than promulgating a rule, if the voluntary standard is likely to eliminate or adequately reduce the risk of injury associated with these products, and if compliance with the voluntary standard is likely to be substantial. Two revised voluntary standards for portable generators have been adopted since the NPR to include CO hazard mitigation requirements. Specifically, in 2018, Underwriters Laboratories (UL) published the voluntary standard UL 2201, *Standard for Safety: Carbon Monoxide (CO) Emission Rate of Portable Generators* (2nd Ed.; 2018), which includes a requirement for a maximum weighted CO emission rate of 150 grams per hour (g/h)[1] and a requirement for the generator to shut off when the CO concentration, measured 1 foot above the centerline of the top of the generator, reaches 400 parts per million by volume (ppmv) or before exceeding a 10-minute rolling

[1] Staff estimates the 150 g/h emission rate represents a CO emission rate reduction of approximately 50 percent for the smallest portable generators to approximately 95 percent for the largest portable generators included in the scope of the draft proposed rule.

average of 150ppmv .[2] Later the same year, the Portable Generator Manufacturers Association (PGMA) published the voluntary standard, ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators* (PGMA G300), which lacks CO emission-rate requirements but includes a requirement for generators to shut off before the CO concentration, measured 1 to 2 inches above the approximate center of the portable generator's top surface, exceeds an instantaneous measurement of 800 ppmv or a 10-minute rolling average of 400 ppmv..[3] PGMA G300 has other requirements, including several requirements specific to notifying consumers if the generator automatically shuts off in response to CO. UL 2201 does not include any of these other requirements.

This memorandum, prepared by staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), assesses whether notification requirements similar to those in PGMA G300 are reasonably necessary, and offers recommendations for such requirements for staff's draft proposed rule.

II. Discussion

A. Need for CO Shutoff Notification Requirements

During its review of existing voluntary standards for portable generators, CPSC staff noted that PGMA G300 includes several requirements specific to notifying consumers if the generator automatically shuts off in response to detecting sufficiently high levels of CO in its vicinity. A summary of these requirements can be found in the next section of this memorandum. In contrast, UL 2201 lacks such notification requirements, even though it too includes CO shutoff performance requirements.

ESHF staff considers CO shutoff notification requirements to be reasonably necessary for any portable generator standard that includes CO shutoff performance requirements. Although performance requirements that automatically shut off a portable generator in response to high levels of CO can be effective in reducing the risk of injury or death from CO poisoning, consumers must be notified about the reasons the portable generator shut off and what actions consumers should take in response to the shutoff to effectively reduce the risk associated with continuing to operate the generator in the way that led to the shutoff. Failing to provide consumers with this information could lead consumers to believe that the generator is malfunctioning or that the shutoff was accidental, rather than the generator intentionally shutting off because of high CO levels, and could lead consumers to restart the generator repeatedly in response to the shutoff. Such actions would result in rising CO levels that increase the potential for CO poisoning. Moreover, even if consumers are aware of the reasons for the generator shutting off, a lack of information about steps consumers should take in response to the shutoff would require consumers to infer the appropriate response and could result in similar behaviors—repeated restarting of the generator in the same location—or could lead consumers to take other actions that do not effectively address the situation (e.g., attempt to bypass the CO

[2] Parts per million by volume is a measurement of concentration on a volume basis. This is commonly used to measure the concentration of gas.

[3] As stated by PGMA, the auto-shutdown stops the generator from running when carbon monoxide begins to accumulate because of operation in enclosed spaces. (PGMA press release, dated April 2018, available online at https://www.pgmaonline.com/pdf/078BDCSUBAttUpdatedPGMAG300StandardRelease2018Final042518x.pdf)

shutoff system),[4] and therefore, increase the potential for CO poisoning despite the presence of the shutoff system.

A. PGMA G300 CO Shutoff Notification Requirements

The PGMA G300 shutoff "notification" requirements consist of two main parts: (1) a "red indication" (section 3.9.1.3.1) and (2) associated product markings.

The voluntary standard does not specify many of the qualities of the "red indication." For example, the standard permits the indication to be "blinking, with a maximum period of 2 seconds" (3.9.1.3.1), but this is not required and there is no requirement for the indication to be illuminated. However, the standard does require that the indication:

- be able to be viewed by a user with normal vision, under expected visibility conditions (3.9.1.3);
- be "prominent and conspicuous … in a readily visible location" that is "not easily obscured during use" (3.9.1.3);
- contrast with the background color (3.9.1.3);
- "remain" for at least 5 minutes after shutoff occurs, or until the generator is restarted (3.9.1.3.1);
- not be present if the generator is restarted (3.9.1.3.1); and
- be labeled or marked with an indication of its function and the required action to activate its function (4.1.1.1.3).

As noted, the voluntary standard also requires product markings that relate to the notification system. These markings include the following, which must be "in a readily visible location" (7.2.2.4):

- An identification of the hazard associated with tampering with the CO shutoff system.
- An identification and description of the CO shutoff system notifications that are "in close proximity to each CO shutoff notification."
- An identification of the engine exhaust, including instructions to direct the exhaust away from occupied structures.[5]
- A label with the content shown in Figure 26, and that must be "in close proximity to the notification."

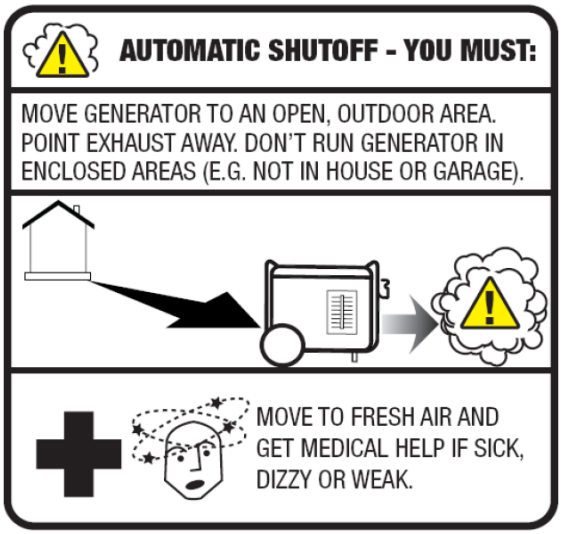

FIGURE 26. G300 notification-related label.

[4] For example, staff is aware of several videos on social media of people instructing how to bypass or defeat the CO shutoff system on current shutoff-equipped generators (*e.g.*, https://www.youtube.com/watch?v=w4KSuNPtpyU, https://www.youtube.com/watch?v=PJ4HV-6LDIs, https://www.youtube.com/watch?v=UjEHYIWNCkY). Some of these videos include numerous follow-up comments from other consumers stating that they had already followed, or were intending to follow, the instructions for their portable generator.

[5] Although these markings do not directly refer to the notification system, they are relevant to the notification label identified in the next bullet, which refers to the appropriate positioning or direction of the generator exhaust (*i.e.*, "POINT EXHAUST AWAY").

B. ESHF Staff Assessment of CO Shutoff Notification Requirements

1. Notification Indicator Requirements

ESHF staff considers the notification requirements in PGMA G300 to be a reasonable foundation, or basis, for similar requirements in the draft proposed rule for portable generators. However, staff assesses the "indication" requirements specified in PGMA G300 to be insufficient for the draft proposed rule, for the reasons outlined below. Staff concludes that the following revisions to the indication requirements of PGMA G300 would further reduce the risk of injury or death associated with portable generators:

- *Require that the "red indication" be illuminated*. PGMA G300 permits, but does not require, the "red indication" to be "blinking," which suggests that the indication *can* be illuminated. However, PGMA G300 does not require the indication to be illuminated. Human engineering and human factors guidelines for displays most commonly recommend illuminated (also known as "transilluminated") indicators, generally taking the form of simple indicator lights or legend lights for detectability. For example, the Department of Defense human engineering design criteria standard, MIL-STD-1472H (2020),[6] requires steady red indicator lights to be used to alert an operator that a system, or a part of a system, is inoperative, or that the successful operation of the system is not possible until an appropriate corrective action is taken (5.2.3.3.4). Woodson, Tillman, and Tillman (1992) similarly identify steady red indicator lights as being typical characteristics of malfunction indicators, and Sanders and McCormick (1993) recommend the use of a steady indicator light to represent a continuous, ongoing condition. These characteristics are consistent with the intended function of the CO shutoff notification system, and therefore, support a requirement for the red indication to be illuminated. Based on this recommendation, all future references to the "indication" in this memo will use "indicator," unless staff is referring specifically to the PGMA G300 indication requirement.

- *Require the indicator to meet the visibility and conspicuousness requirements relative to a consumer who is positioned in front of the startup controls*. PGMA G300 specifies that the indication must be prominent, conspicuous, and in a "readily visible location" that is "not easily obscured during use." Although ESHF staff generally concurs with these requirements, the requirements do not provide context regarding where around the generator one would make this assessment. For example, an indicator could meet all of these criteria when the consumer is facing a particular side of the portable generator, but consumers might not be facing that side, and could even be on the opposite side, when the indicator is needed.[7] Warnings and indicators should be located when and where consumers are likely to be looking when needed (Wogalter & Vigilante, 2006), and for two reasons ESHF staff recommends that the indicator be required to be readily visible from the portable generator's startup controls. First, some consumers' initial response to the generator shutting off, particularly if it shuts off soon after startup, will be to attempt to restart the generator. In that event, consumers are likely to be focusing their attention on the startup controls. Second, even if consumers do not *immediately* try to restart the generator after a shutoff event, the primary hazard scenario of concern with respect to

[6] This standard establishes general human engineering criteria for the design and development of military systems, equipment, and facilities, but are based on human factors principles that are broadly applicable to a wide range of equipment and products, including consumer products.

[7] In addition, MIL-STD-1472H states that transilluminated indicator lights must be unobstructed relative to the user's expected viewing position (5.2.3.1.10).

the notification system would be the consumer restarting the generator without first moving the generator to a more open, outdoor location, as instructed by the accompanying notification label. Positioning the indicator, and associated label, near the startup controls increases the likelihood that consumers will notice the indicator and follow the recommended action before restarting.

- *Require the red indicator to be at least 0.4 inches diameter in size*. PGMA G300 does not include any size requirements for the indication, meaning an indication of any size would be permitted. Human engineering guides generally recommend that indicator lights should subtend at least 1 degree of visual angle (Boff & Lincoln, 1988; Sanders and McCormick, 1993). The actual viewing distance for a consumer who is operating the startup controls on a generator is unknown, and likely varies considerably depending on the user. However, ESHF staff estimates that a viewing distance of about 17 inches, and as much as 26 inches, is reasonably foreseeable.[8] Assuming a visual distance of up to about 26 inches would yield a minimum indicator size of 0.45 inches; a shorter visual distance would yield a smaller allowable indicator size.[9] Consistent with this, MIL-STD-1472H specifies that simple red indicator lights should be up to ½ inch in size, and Woodson, Tillman, and Tillman (1992) state that malfunction indicator lights are typically ½-inch diameter or smaller. Taken as a whole, these estimates and guidelines suggest that a reasonable minimum indicator size would be smaller than, but approaching, 0.5 inches. ESHF staff considers a minimum indicator size of 0.4 inches, or 10 mm, diameter to be a reasonable requirement.

- *Specify that the indicator, if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark durations*. Staff is unclear of the basis for PGMA G300's current maximum "blinking" period of 2 seconds; however, a period, or interval, of 2 seconds would be equivalent to 0.5 Hz, which is well below the flashing rate recommended in human engineering guidelines to improve the likelihood that the flashing will be detected. PGMA G300 also does not place any lower bound on the period, which could result in a flash rate so rapid as to render the light indistinguishable from a steady light. Although ESHF staff does not consider requiring a flashing light to be necessary,[10] an allowance for a flashing light implies that the flashing characteristic might be desired by some manufacturers, and in those cases an upper bound should be placed on the flashing frequency to prevent the light from being perceived as steady. Sanders and McCormick (1993) recommend a flashing rate of 3 to 10 Hz. PGMA G300 also does not provide any bounds on the duration of each flash (*i.e.*, how long the light must remain lit), meaning one could have the light illuminate for an extremely brief

[8] This range roughly approximates the distance between the eyes and a forward grip with straight arms. Specifically, 17 inches represents the approximate difference between the 5th percentile forward grip reach for an adult female (smallest forward grip reach from back), minus the 95th percentile measurement from the corner of the eye to the back of the head for an adult male (largest distance to eye corner from back); 26 inches represents the approximate difference between the 95th percentile forward grip reach for an adult male, minus the 5th percentile measurement from the corner of the eye to the back of the head for an adult female (Peebles & Norris, 1998). These estimates are maintained even if gender is held steady to calculate the minimum and maximum viewing distances; that is, using solely female dimensions to calculate the minimum viewing distance still yields 17 inches and using solely male dimensions to calculate the maximum viewing distance still yields 26 inches.

[9] Minimum indicator size at 26 inches = 26 inches (tan 1°) = 0.45 inches. Minimum indicator size at 17 inches = 17 inches (tan 1°) = 0.30 inches.

[10] Flashing red indicator lights should be limited to emergency conditions that imply an impending disaster (Woodson, Tillman, & Tillman, 1992) or otherwise require an immediate response. However, because the indicator light in question would activate when the generator has automatically shut off, there would be no need for an *immediate* corrective action to avoid the CO poisoning hazard. A flashing light might be necessary for improved detection if there are other illuminated lights on the display; however, if any other background lights are flashing, then a steady light would be preferred (see, for example, Sanders & McCormick, 1993).

duration, and remain off for the remainder of the period. Thus, staff recommends that the draft proposed rule specify that the indicator, if flashing, must have equal light and dark periods.

In addition to the recommendations above, ESHF staff recommends seeking public comments on the following issues:

- *Minimum indicator brightness or luminance*. PGMA G300 does not specify the brightness of the indication, suggesting that even if the indication took the form of an indicator light, such a light could be so dim as to be nearly indistinguishable from being off. Staff believes that a brightness, or illumination requirement might be needed to allow consumers to easily differentiate between the conditions where the indicator is illuminated versus not. Human engineering guides generally recommend that indicator lights and visual alerting signals have luminance that is at least twice as great as the background, or other visual displays, to minimize detection time (Boff & Lincoln, 1988; Sanders and McCormick, 1993), and MIL-STD-1472H requires that the luminance not exceed three times the surrounding luminance, when glare is a concern (5.2.3.1.13.6). However, one challenge associated with using these recommendations to specify a minimum absolute luminance level for the indicator is that portable generators might be used in a wide range of different environmental conditions with varying background illumination levels. A minimum luminance of 30 cd/m^2 is frequently recommended for the bright areas of a display in an illuminated interior (Murch, 1984 as cited in Cushman & Rosenberg, 1991). MIL-STD-1472H requires a similar minimum luminance level, specifying that visual displays must be capable of luminance levels of at least 35 cd/m^2 (5.2.1.2.2). However, these luminance requirements appear to apply primarily to illuminated panels or displays and might not be as relevant to simple indicator lights, particularly those on a product that may be used a bright outdoor environment. Staff suggests public comments whether a minimum luminance requirement is needed for the notification indicator, and if so, what would be an appropriate requirement.

- *Minimum indicator duration, if not restarted*. PGMA G300 specifies that the indicator must “remain” for at least 5 minutes after shutoff occurs, or until the portable generator is restarted. Although ESHF staff agrees that the indicator should not remain illuminated after the generator has restarted, staff questions whether 5 minutes is an appropriate minimum duration for the indicator to remain. A requirement that would permit the indicator to no longer be present after 5 minutes have passed would mean that consumers who are not present when the generator has shut off, do not notice that the generator has shut off, or otherwise do not return to the generator within 5 minutes after shutoff will not necessarily be provided with the information needed to confirm that the generator has shut off due to elevated levels of CO and that the generator should be moved to another location before restart. Although some consumers might be able to infer that elevated CO levels is the cause of the generator no longer running, consumers should not be required to infer this information, given the potentially lethal consequences associated with operating a portable generator in a hazardous location. Staff has considered removing this time limit from the requirement, so the indicator would be required to remain on until the generator has been restarted. However, staff recognizes that it might not be reasonable to have a potentially unlimited duration requirement for an indicator light, and that a more appropriate requirement would base the duration on the amount of time needed before CO concentrations in the environment have dropped to a reasonably safe level. Staff is uncertain whether 5 minutes achieves this goal, particularly given the range of possible environmental conditions, and suggests public comments on this issue.

2. Notification-Related Marking and Labeling Requirements

ESHF considers the notification-related marking and labeling requirements in PGMA G300 to be a reasonable basis for similar requirements in the draft proposed rule for portable generators. For example, staff agrees with the PGMA G300 requirements for portable generators to be marked with the location of the engine exhaust and instructions to direct the exhaust away from occupied structures, and the requirement is worded in a way that allows for substantial flexibility regarding how to communicate these two issues. Staff also agrees with the PGMA G300 requirement for portable generators to be marked with the "hazard due to tampering with" the CO shutoff system and to identify and describe the CO shutoff system notifications "in close proximity to each CO shutoff notification."

However, staff concludes that the PGMA G300 requirements specific to the label are insufficient and that certain revisions are reasonably necessary to adequately reduce the risk of injury or death associated with portable generators. Staff recommends the following changes to this label:

- *Require the label to be located no more than 0.25 inches from the notification indicator, or for the indicator to be incorporated into the label*. PGMA G300 specifies that the notification label must be "in a readily visible location … in close proximity to the notification" (7.2.2.4); however, it is unclear how "close" the label must be to the notification indicator to meet the requirement. Given that the label is intended to communicate to consumers what must be done when the CO shutoff system activates, staff recommends that the label be located where consumers are likely to be looking when they are notified that the generator has shut off due to elevated CO levels. Moreover, the label tells consumers actions they "must" take because of the shutoff, which means the information in the label only applies when the shutoff system has activated. Woodson, Tillman, and Tillman (1992) recommend that panel labels generally be located 0.25 inches from the item being labeled. Thus, staff concludes that the best approach would be to specify that the label must be located no more than 0.25 inches, or 6.35 mm, from the notification indicator, or for the indicator to be incorporated into the label in some manner (*e.g.*, place the indicator within the perimeter of the label, design the label so the top panel functions as the indicator and illuminates when the shutoff system has activated).

- *Change the language of the header to state explicitly why the generator shutoff*. The label specified in PGMA G300 instructs consumers what to do in response to the generator shutting off but does not explain why the generator shutoff. Consumers should not be required to infer why they should move the generator, and an explicit description of the potential hazard associated with not performing the recommended action is more likely to increase the perceived threat, or hazardousness of the situation (Laughery & Paige Smith, 2006), which increases consumers' motivation to comply with the recommended action (Kalsher & Williams, 2006; Riley, 2006). This information might be even more important for a consumer who is not the original owner or purchaser of the generator, or who is not the consumer who normally operates the generator, all of whom might be less familiar, or entirely unfamiliar, with the purpose and intended function of the CO shutoff system. Thus, staff recommends that the phrase "YOU MUST" be replaced with "HIGH LEVELS OF CARBON MONOXIDE." Staff recognizes that this latter phrase takes up more space, but this can be accomplished without resizing the text by reformatting the header to be two lines in height, as illustrated in FIGURE 27.

FIGURE 27. Illustration of staff's recommended revision to header text, in available space.

- *Reformat the text in the message panels to use sentence capitalization rather than all-uppercase text, except when highlighting key phrases*. Words in all-uppercase text are less legible than words in lowercase text, and all-uppercase text is less readable than mixed-case text (*i.e.*, both uppercase and lowercase letters) particularly under low-light conditions or for longer strings of text (Frascara, 2006; Wogalter & Vigilante, 2006).

- *Revise the language to clarify that the generator must be moved before restarting the generator, and to reduce redundancy with the content of the mandatory DANGER label*. The primary function of the notification label is to explain why the generator shut off, and what actions the consumer should take before restarting the generator; the label is not intended to reiterate the information that is already present on the mandatory DANGER label.[11] Generally, unnecessary or redundant information should be removed from warnings to improve the likelihood that consumers will read and encode all the information (Laughery & Paige Smith, 2006), and the same principle can be applied to the notification label. Presenting redundant information could lead some consumers to stop reading the label, believing that there may be no new information to which they must attend,[12] and might frustrate consumers who are not using the generator in an enclosed space, but are being told not to do so in response to the shutoff.[13] Staff concludes that a better approach would be for the notification label to focus on providing information not already available in the DANGER label and to refer consumers to the DANGER label and product manual for additional information about the hazard and proper placement. This approach has the added benefit of avoiding the PGMA G300 label's use of Latin abbreviations, such as "e.g.," which are not readily understandable by some consumers and do not meet common plain-language and readability guidelines (*e.g.*, PLAIN, 2011). Staff also recommends that consumers be told upfront to move the generator to a "more open" outdoor area "before restarting," to emphasize that moving the generator is directly relevant to restarting the generator, and to make it clear that even if consumers believed that the generator was already in an open area, the generator must be moved to a *more* open area.

- *Add sizing requirements for the label in terms of the minimum allowable type size for the contents*. PGMA G300 currently does not include any requirements for the size of the label, suggesting that a label of any size, even one too small to be reasonably legible or readable, would be permitted. ESHF staff measured the text in the label presented in PGMA G300, under the assumption that the label is presented in actual size. The header text measures approximately 0.12 inches in height and the remaining text is printed in text whose uppercase letters measure about 0.10 inches in height. Staff considers these to be reasonable dimensions and recommends that draft proposed rule specify these as the minimum text size for the label.

[11] The mandatory DANGER label can be found at 16 CFR part 1407, *Portable Generators: Requirements to Provide Performance and Technical Data by Labeling*.

[12] In addition, Wogalter and colleagues (1987) found that warning signs with information that was redundant or already implied by other parts of the warning were rated lower in perceived hazardousness than similar warning signs without this redundant information.

[13] Moreover, consumers who already are not using the generator indoors, but seemingly are being told not to use the generator indoors in response to the generator shutting down, may view the information being presented as not relevant to them, and therefore, ignore the information.

III. Conclusions

ESHF staff concludes that CO shutoff notification requirements are reasonably necessary for any standard that includes CO shutoff performance requirements to increase consumer awareness about why a sudden shutoff might have occurred and to communicate what actions consumers should take in response to the shutoff to adequately reduce the risk of CO poisoning. ESHF staff considers the notification requirements in PGMA G300 to be a reasonable basis for similar requirements in the draft proposed rule for portable generators. However, staff recommends several changes to the indication and labeling requirements pertaining to the CO shutoff notification system that staff concludes are reasonably necessary to adequately reduce the risk of injury or death associated with portable generators.

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TAB G: Comments on the 2016 NPR

United States
Consumer Product Safety Commission
cpsc.gov | info@cpsc.gov | 800.638.2772

Memorandum

TO: The File **DATE:** January 28, 2023

THROUGH: Duane Boniface, Assistant Executive Director, Office of Hazard Analysis and Reduction (EXHR)

FROM: Portable Generator Team

SUBJECT: Comments on the 2016 NPR

I. Background

Based on changes to the draft proposed requirements in the SNPR compared to those initially proposed in the NPR, many of the comments to the 2016 NPR are no longer applicable. Many have been addressed through staff's subsequent simulation plan and effectiveness analysis of the CO mitigation requirements in the voluntary standards. Following is a summary of and response to significant comments received following publication of the 2016 NPR.

II. Comments and Staff's Responses

1. Different emission rates based on engine size. Four commenters (PGMA, Briggs & Stratton, Champion Power Equipment, and Generac) objected to the 2016 NPR's proposal of four different levels of maximum CO emissions levels depending on the size of engine.. Commenters claimed that the tiered emission levels were based on achievable rates using best available technology rather than on evidence regarding the safety of the levels. These commenters claimed that the impact on consumer safety or the reduction of CO injuries was not clearly presented for each of these tiered levels.

Response: The proposed requirements detailed in this SNPR do not require different rates for different engine sizes. The requirements of the current proposed rule, which are applicable to generators of all engine sizes, are expected to eliminate nearly all deaths and most injuries.

2. Mandatory label for portable generators has accomplished what is necessary. Two commenters (PGMA, Briggs & Stratton) claimed that, since the introduction of CPSC's 2007 mandatory portable generator safety label [14,15] the rate of unintentional CO fatalities associated with portable generators had decreased.

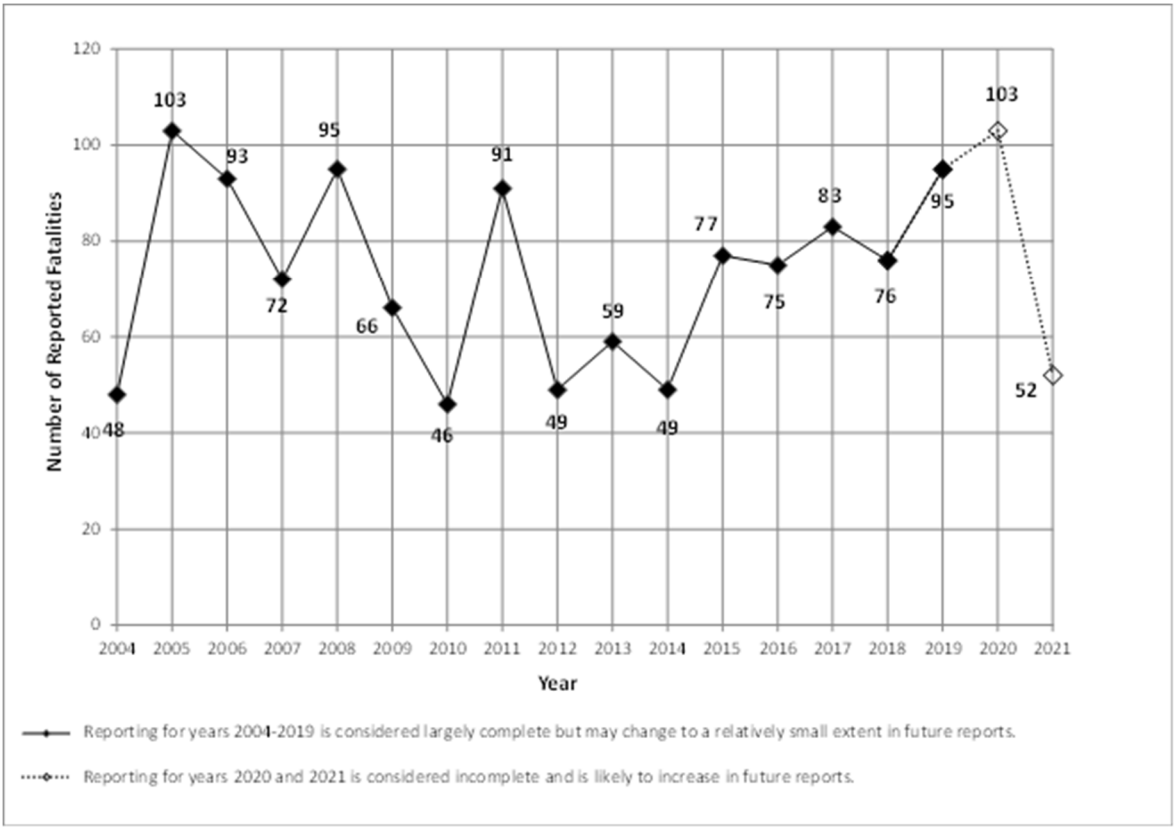
Response: Staff disagrees. The effective date of CPSC's mandatory label was February 2007, which was more than 15 years ago. As the data show, there has been no obvious and consistent reduction in CO fatalities since that time, and CO fatalities associated with portable

[14] 72 Fed Reg 1443 (January 12, 2007)

[15] 72 Fed Reg 2184 (January 18, 2007)

generators have been increasing in recent years. See Figure 1.[16] [17] While data collection is ongoing, the number of CO deaths caused by portable generators in year 2020 is likely to exceed the highest number of annual deaths over the reporting period of 2004 to 2021, which occurred in 2005 (103 deaths), prior to the mandatory label.[18]

Figure 1. Number Of Reported Non-Fire CO Poisoning Deaths Involving Generators in CPSC Databases as of May 10, 2022, by Year, 2004-2021



3. Include compression units within the scope of the rule. One commenter (PGMA) stated that any proposed requirement should be applicable to all portable generators, not just spark-ignited

[16] Death data for years 2004 through 2010 is from the following report, with an additional death included in 2004 that was reported in the NEISS data but was not previously accounted for: Hnatov, M.V., *Generators Involved in Fatal Incidents, by Generator Category, 2004-2014*, U.S. U.S. Consumer Product Safety Commission, Bethesda, MD, September 2016. (TAB B in https://www.cpsc.gov/s3fs-public/Proposed-Rule-Safety-Standard-for-Portable-Generators-October-5-2016.pdf; Document ID CPSC-2006-0057-0032 in www.regulations.gov)

[17] Death data for years 2011 through 2021 is from the following report, with 5 deaths from 3 incidents in 2011 excluded because they involved stationary generators, which are outside the scope of the draft proposed rule: Hnatov, M.V., *Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine-Driven Tools, 2011–2021*. U.S. Consumer Product Safety Commission, Bethesda, MD, June 2022 https://www.cpsc.gov/content/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021 (Document ID CPSC-2006-0057-0108 in www.regulations.gov)

[18] For example, in staff's annual report covering the years 2010 through 2020, the number of deaths entered in CPSC's databases as of May 17, 2021 for the years 2019 and 2020 was 89 and 54, respectively. The deaths in each of these years increased to 95 and 103, respectively, in the June 2022 report referenced in footnote 17, when the data was pulled almost exactly one year later. https://www.cpsc.gov/content/Generators-and-OEDT-CO-Poisoning-Fatalities-Report-2021

units. The commenter pointed out that compression units are within the scope of ANSI/PGMA G300.

Response: Staff disagrees. Compression Ignition (CI) engines[19] (i.e., diesel engines) emit significantly less CO compared to spark ignited (SI) engines. CPSC staff is not able to confirm any fatality as involving a diesel generator. Furthermore, diesel generators are primarily used by individuals in a work-related setting or environment, and typically are not consumer products. Thus, staff does not recommend that diesel generators be included in the scope of the draft proposed rule.

4. CO shutoff system. Four commenters (PGMA, Briggs & Stratton, Generac, and Champion) stated that the 2016 NPR did not adequately consider the potential for using generator shut off concepts. The commenters asserted that the CO shut off solution was a more feasible and reliable solution to that proposed in the 2016 NPR.

Response: This comment is no longer applicable as the draft proposed rule includes requirements for a CO shutoff system. The concept of a CO shut off sensor to mitigate the CO hazard was not developed at the time of the 2016 NPR. In 2014, staff sent a letter to UL requesting that UL form a task group (TG) to develop CO mitigation requirements. Staff's recommendations included that the TG consider a shut off system, and staff subsequently made two presentations to the TG on the shut off concept.[20,21,22] A subgroup within the UL task group assessed that a shut off system was not feasible.[23] Consequently, staff's 2016 NPR focused on reduced emissions. In September 2016, just prior to the 2016 NPR, PGMA stated in a letter to the then-Chairman that PGMA's technical committee would begin work on developing requirements for the shutoff concept.[24] Both PGMA and UL published revised editions of their standards in 2018 to include CO shutoff requirements. Staff is recommending that the shutoff concentrations of UL 2201 and the durability, self-monitoring, tamper resistance, test method, notification, and marking, labeling, and instructional requirements of PGMA, with modifications, be included in the draft proposed rule.

5. Modeling of generators running outdoors. Two commenters (PGMA and Briggs & Stratton) stated that CPSC needs to conduct modeling of generators running outdoors.

[19] Compression ignition engines use a higher compression ratio than a spark ignition (SI) engine to heat air in the engine cylinder, and thus do not use a spark plug to ignite the air-fuel mixture, as is the case for a SI engine . See section III.A. in the briefing memorandum for a definition of spark ignition engine.

[20] Staff letter to UL, January 2014 https://www.cpsc.gov/s3fs-public/pdfs/blk_pdf_CPSCstafflettertoULdatedJan142014.pdf.

[21] Staff presentation to TG, May 2014 https://www.cpsc.gov/s3fs-public/pdfs/blk_pdf_UL2201TaskGroupMeeting051314.pdf

[22] Staff presentation to TG, July 2014 https://www.cpsc.gov/s3fs-public/pdfs/blk_pdf_UL2201TaskGroupMeeting070214.pdf

[23] Log of meeting for meeting with PGMA on 12/10/2015. https://www.cpsc.gov/s3fs-public/12-10-15-PGMA-public-meeting-with-CPSC-staff.pdf?VersionId=C5xRL8C4jbkKilWAreFJgZtHaBCEGK3v

[24] PGMA letter to CPSC Chairman https://www.cpsc.gov/s3fs-public/PGMALtrChairKayeVoluntaryStandardFinal.pdf

Response: Staff did testing and modeling of generators running outdoors for use in its effectiveness analysis to assess the effectiveness of the CO-mitigation requirements in each of the voluntary standards.[25,26]

6. Closed loop electronic fuel injection system (EFI) and catalyst. In response to the 2016 NPR, four commenters (PGMA, Generac, Briggs & Stratton, and the Truck and Engine Manufacturers Association) stated that the NPR proposed to reduce CO emission rates using closed loop EFI and 3-way catalysts. Commenters stated that closed-loop EFI can reduce the CO production rate, but the increased heat-release from lean combustion can be detrimental to a catalyst-equipped air-cooled engine's durability, performance, and emissions maintenance. PGMA has also alleged that the elevated exhaust temperatures could lead to burn and fire hazards.

Response: For the 2016 NPR, staff expected that manufacturers likely would use EFI and catalysts to meet the draft proposed rule's CO emission rates; however, no emission control strategies were prescribed in that NPR nor the current SNPR. Since then, staff has observed that one manufacturer's models that are certified to UL2201 do so by using a carburetor, instead of replacing it with EFI, and using a device for secondary air injection into the exhaust stream between the cylinder and a catalyst. (This manufacturer may have made other modifications of which staff is unaware.) Staff is aware of another manufacturer who converts a popular model of a brand name gasoline generator to run on propane by replacing the carburetor with throttle body injection and using a catalyst. (This manufacturer may have made other modifications of which staff is unaware.) Based on this engine's emission certification data[27], which report a very low CO emission rate, this propane generator likely would be able to meet the CO emission rate of the draft proposed rule. However, this manufacturer does not advertise this model as being certified to UL 2201. Finally, staff has observed that another manufacturer has recently introduced a new model to its product line of gasoline generators that uses EFI and a catalyst; this gasoline generator also has a very low CO emission rate, suggesting that it also would be able to meet the CO emission rate of the draft proposed rule. All of these generators are currently in the marketplace. Staff disagrees that the CO emission rate of the draft proposed rule would detrimentally affect engine durability, performance, and emissions or increase risk of fire and burn. Regardless of the emission control strategy used, techniques to address additional heat have been integrated into the engines and applications in which they are used, such as in the examples provided here.

7. Elimination of LPG and dual fuel generators from the market. In response to the requirements in the 2016 NPR, two commenters (Champion and Generac) stated that if EFI is the primary technical solution, the standard will eliminate conventional and dual fuel generators from the market. The commenters stated that LPG and dual fuel generators represent a significant portion of portable generator sales.

Response: Staff disagrees. The draft proposed rule does not prescribe how manufacturers must meet the CO emission rate requirement. Manufacturers are using different emission

[25] NIST Technical Note 2049 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Portable Generators with a CO Safety Shutoff Operating in a Test House*, available online at https://doi.org/10.6028/NIST.TN.2049

[26] NIST TN 2200 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Commercially Available Portable Generators Equipped with a CO Hazard Mitigation System*, available online https://doi.org/10.6028/NIST.TN.2200

[27] available online at https://www.epa.gov/system/files/documents/2022-02/small-nonroad-spark-ignition-2011-present.xlsx

control strategies to lower the CO emission rate to levels staff expects will meet the CO emission rate requirement in the draft proposed rule, including the propane generator discussed in the comment above. Furthermore, due to propane's chemical composition, it produces less CO compared to gasoline, thereby making it less challenging for a propane generator to meet the draft proposed rule than a gasoline generator of equivalent rated wattage.

8. False sense of security. Four commenters (PGMA, Briggs & Stratton, Champion, and Generac) claimed that consumers may mistakenly believe that reduced CO emissions means it is safe to operate a portable generator indoors.

Response: This comment is no longer applicable because the current draft proposed rule does not rely on reduced emissions alone. Nevertheless, in its 2016 NPR briefing package, staff discussed at length industry-expressed concerns that reduced CO emissions could create a false sense of security among consumers who currently operate generators outdoors, prompting them to operate the lower-CO emission generators indoors. Consumers who currently operate generators outside are the people most likely to be aware of the hazards posed by operating a generator indoors and to consider such behavior to be risky. These improved generators would also have the potential to reduce the incidence of CO poisoning and death among consumers who would be inclined to operate even current generators in an enclosed or partially enclosed space. The new draft proposed rule's addition of a shutoff requirement, similar to that supported by PGMA, further reduces the risk of death and injury from these products.

9. PGMA G300. Three commenters (PGMA, Generac, Briggs & Stratton) asserted that the proposed revision to PGMA G300 will address nearly all fatalities resulting from misuse in enclosed spaces.

Response: Staff disagrees. Staff's effectiveness analysis that replicated 511 actual generator-related CO deaths in CPSC's databases found that generators complying with PGMA G300 still would have resulted in 69 deaths. Moreover, of the 442 survivors, 142 would have been injured such that 54 would have been hospitalized and 88 would have been treated and released. Additionally, staff's testing of commercially available generators compliant with PGMA G300 and UL 2201, documented in NIST Technical Note 2200,[28] show that two generators that were PGMA G300-compliant, when run in an attached garage with the bay door fully open, did not result in localized CO levels sufficient to activate the CO shutoff system, yet resulted in CO concentrations in the living space of the house that would have caused injuries to the home's occupants. In one test, the generator ran out of fuel after 329 minutes, resulting in COHb values for theoretical occupants in the house that peaked in the range of 27 percent to 37 percent. This is in the range of where symptoms such as severe headache, nausea, vomiting, and cognitive impairment are expected to occur. In the other test, the generator ran for 468 minutes before the test operator manually shut the generator off because of time constraints and stopped data collection. The COHb values for theoretical occupants at the time the generator was stopped ranged from 20 percent to 26 percent, which is in the range of where symptoms such as throbbing headache and mild nausea are expected to occur. Furthermore, PGMA G300 does not address deaths and injuries from generators used outdoors, where local CO concentrations are less likely to build to a sufficient level to activate the CO shutoff system,

[28] NIST TN 2200 *Carbon Monoxide Concentrations and Carboxyhemoglobin Profiles from Commercially Available Portable Generators Equipped with a CO Hazard Mitigation System*, available online https://doi.org/10.6028/NIST.TN.2200

as evidenced by the 3-fatality incident involving a PGMA G300 generator used outside and near the home.[29]

[29] Redacted IDI in document ID number CPSC-2006-0057-0110 in www.regulations.gov.

TAB H: Description of Recommended Requirements for Draft Proposed Rule to Establish a Safety Standard for Portable Generators

United States
Consumer Product Safety Commission
cpsc.gov | info@cpsc.gov | 800.638.2772

Memorandum

TO: The File **DATE:** January 28, 2022

THROUGH: Duane Boniface, Assistant Executive Director,
Office of Hazard Analysis and Reduction (EXHR)

FROM: Portable Generator Team

SUBJECT: Description of Recommended Requirements for Draft Proposed Rule to Establish a Safety Standard for Portable Generators

I. Introduction

This memorandum provides staff's description of the recommended requirements for the draft proposed rule.

II. Scope

Portable generators that are within the scope of the draft proposed rule include single phase, 300 V or lower, 60-hertz generators that are provided with receptacle outlets for the AC output circuits and intended to be moved, though not necessarily with wheels. The engines in these "portable" generators are nonroad small spark ignition (SI) engines, based on the U.S. Environmental Protection Agency's (EPA) engine classifications per 40 CFR § 1054.801, and are fueled by gasoline, liquefied petroleum gas (LPG), or natural gas (NG).

For purposes of this rule, portable generators would not include:

(1) Permanent stationary generators;

(2) 50-hertz (Hz) generators;

(3) Marine generators;

(4) Generators permanently mounted in recreational vehicles or motor homes;

(5) Generators solely intended to be pulled by, or mounted on, vehicles;

(6) Generators with compression ignition engines;

(7) Industrial-type generators intended solely for connection to a temporary circuit breaker panel at a jobsite, and not for consumer use.

III. Effective Date

The draft proposed rule applies to any portable generator manufactured after 180 days after publication of the proposed rule in the Federal Register.

IV. Definitions

In addition to the definitions in section 3 of the Consumer Product Safety Act (15 U.S.C. 2052), the following definitions apply to the draft proposed rule:

(1) *Units*, as defined in section 2.1 of UL 2201.

(2) *Air change rate*, as defined in section 2 of PGMA G300-2018.

(3) *CO analyzer*, as defined in section 2 of PGMA G300-2018.

(4) *Engine*, as defined in section 2 of PGMA G300-2018.

(5) *Ordinary tools*, as defined in section 2 of PGMA G300-3018.

(6) *Portable generator system for controlling CO exposure*, as defined in section 2 of PGMA G300-2018.

(7) *CO shutoff system*. Same as portable generator system for controlling CO exposure.

(8) *Rated wattage*. The output power rating of a portable generator as determined by section 6.3.2 of PGMA G300-2018.

(9) *Maximum available observed wattage*. Same as rated wattage.

(10) *Test room*. A fully enclosed space with a volume of 895 – 2100 ft^3 (25.34 – 59.47 m^3) and a ceiling height of 8 – 12 ft (2.44 - 3.66 m). The room dimensions shall allow for the requirements of the generator position to be met. The generator shall be positioned such that the exhaust jet centerline is along one of the room centerlines; the exhaust outlet on the generator is at least 6 ft (1.83 m) from the opposite wall; the outer surfaces of the generator housing or frame is at least 3 ft (0.91 m) from the walls on all other sides; and the onboard CO sensor used for the CO safety shutoff system is at least 1 ft (0.30 m) away from any obstruction. The room shall be constructed to control ventilation within a range of 0.1 – 1.0 air changes per hour (ACH). Ventilation shall be induced by a fan on the air outlet. The configuration of the air inlet and outlet for ventilation shall be designed such that neither port creates a flow directly onto or near the CO analyzer sample port above the generator or the CO sensor onboard the generator that is used as part of the CO safety shutoff system. The CO sample port connected to the CO analyzer for determining the concentration of CO within the test room shall be placed 1 ft (0.30 m) above the center point of the portable generator's top surface.

V. CO Emission Rate Requirements and Test Methods

The draft proposed rule requires UL 2201's emission rate requirement, that the calculated weighted CO emission rate of the generator shall not exceed 150 g/h, using one of two test method options provided in Section 5 of UL 2201 ("Option 1" and "Option 2"). Section 5.2 of UL 2201 provides Option 1, "Portable Generator Assembly CO Emissions Method." Section 5.3 of UL 2201 provides Option 2, "Portable

Generator Engine-Only CO Emissions Method." In the first test method option, the "maximum available observed wattage," defined as the "rated wattage," is determined by Section 6.3.2 of PGMA G300.

VI. CO Shutoff Criteria

The draft proposed rule adopts the CO concentrations specified in section 6.5.2 and 6.5.3 of UL 2201 into section 6.2.11.1 of PGMA G300.

VII. Test Methods and Requirements for the CO Shutoff System

(1) The draft proposed rule incorporates by reference the test procedure requirements in 6.2.11.2 of PGMA G300 and the corresponding definitions in Section 2 of PGMA G300 to verify that the CO shutoff system shuts the portable generator off before, or when, CO concentrations reach the prescribed limits, with the following changes:

a. PGMA G300 specifies that the room length and width are to be within 20 percent of each other. The draft proposed rule instead requires the test room volume and dimensions to be 895 – 2100 ft^3 (25.34 – 59.47 m^3) with a ceiling height of 8 -12 ft (2.44 - 3.66 m) and for the room dimensions to allow for the requirements of generator position to be met. .

b. PGMA G300 specifies that the generator is to be placed in the approximate center of the room. The draft proposed rule modifies this to instead require that the generator be positioned such that the exhaust jet centerline is along one of the room centerlines; the exhaust outlet on the generator be at least 6 ft (1.83 m) from the opposite wall and at least 3 ft (0.91 m) from the walls to the other sides; and the onboard CO sensor used for the CO safety shutoff system be at least 1 ft (0.30 m) away from any obstruction.

c. The draft proposed rule modifies the location of the CO sample port that is used to draw a sample from within the chamber and sent to the CO analyzer to measure the CO concentration in the room from the specification in PGMA G300 of 1 – 2 inches above the top surface of the generator to 1 ft (0.30 m) above the center point of the top of the generator.

d. PGMA does not specify the configuration of the air inlet and outlet for ventilation purposes. The draft proposed rule requires that the configuration of the air inlet and outlet for ventilation of the test room be designed such that neither port creates a flow directly onto or near the CO analyzer sample port above the generator or the CO sensor onboard the generator that is used as part of the CO safety shutoff system.

e. The draft proposed rule changes the ventilation rate specification in PGMA G300 from 0 to 1 ACH (air changes per hour) to 0.1 – 1.0 ACH. The draft proposed rule also requires that the fan used to induce ventilation be placed on the air outlet as an exhaust fan and that no fan can be used on the air inlet.

f. The draft proposed rule requires that the load bank be of a resistive type that is capable of adjustment to within 5 percent of the required load range. The power meter be capable of measuring electrical loads to within 5 percent.

(2) The draft proposed rule incorporates by reference the requirements in section 3.9.1.2.2 through 3.9.1.2.4 of PGMA G300 to ensure the functionality of the CO shutoff system is maintained, as well as

the definition for “ordinary tools” from PGMA G300. In addition, the draft proposed rule incorporates by reference the requirements in section 3.9.1.2.1 by reference with two modifications. The first modification is an additional requirement that shorting, disconnecting, or removing any part that disables the operation of the system shall prevent the engine from running. The second modification deletes “removal or disconnection of the part prevents the engine from running” as an optional means to achieve tamper resistance since it is required as stated in the first modification. This modification also moves “or” from the end of second optional means to the end of the first optional means.

(3) The draft proposed rule incorporates 3.9.1.1 of PGMA G300 by reference to prescribe requirements for self-monitoring of the CO shutoff system.

(4) The draft proposed rule incorporates the requirements in section 3.9.1 and 3.9.1.4 of PGMA G300 by reference, for the construction of the CO shutoff system, with the following changes:

- The concentrations achieved in the test chamber shall be changed from 810 – 850 ppmv to 410 – 450 ppmv and from 410 – 430 ppmv to 160 – 180 ppmv for the purposes of determining activation to the CO shutoff criteria requirements.
- For the instantaneous concentration shutoff requirement, the control system shall initiate a signal to shut off the portable generator before the concentration in the test chamber exceeds 400 ppmv.
- For the average measurement shutoff requirement, the control system shall initiate a signal to shut off the portable generator before the concentration in the test chamber exceeds a 10-minute rolling average of 150 ppmv.

(5) The draft proposed rule incorporates by reference the notification requirements specified in section 3.9.1.3 of PGMA G300, and all subsections thereof, with the following changes:

- In section 3.9.1.3, the notification shall be in a readily visible location to a consumer who is positioned in front of the startup controls.
- In section 3.9.1.3.1, the “red indication” shall be at least 0.4 inches (10 mm) in diameter, illuminated, and if flashing, must flash at a rate of between 3 and 10 Hertz (Hz), with equivalent light and dark durations.

(6) The draft rule incorporates by reference the marking, labeling, and instructional requirements specified in sections 4.1.1.1.3, 7.2, and 8 of PGMA G300, and all subsections thereof, with the following changes to section 7.2.2.4:

- When referring to the placement of the label shown in Figure 5, replace “shall be in close proximity to” the notification with “shall be no more than 0.25 inches (6.35 mm) from” the notification.
- Revise the label shown in Figure 5 as follows:
    - Replace the phrase, “YOU MUST:” with “HIGH LEVELS OF CARBON MONOXIDE.”
    - Replace the language in the second panel with the following: “BEFORE RESTARTING, move generator to a more open, outdoor area. Point exhaust away. See DANGER label and product manual for more information.”
    - In the bottom panel, change replace the phrase “IF SICK” with “if you feel sick.”

- Specify that the text in all but the top panel must be formatted using sentence capitalization, except for the following words and phrases: “BEFORE RESTARTING,” “DANGER,” and “MOVE TO FRESH AIR AND GET MEDICAL HELP.”

- Specify that the text in the top panel, or header, must have letter heights of at least 0.12 inches, and specify that all other text in the label must have text whose uppercase letters measure at least 0.1 inches in height.

VIII. Stockpiling

The draft proposed rule includes an anti-stockpiling provision that would prohibit a manufacturer from “stockpiling” or substantially increasing the manufacture or importation of noncompliant portable generators between the promulgation of the final rule and the effective date. The provision would prohibit the manufacture or importation of noncompliant products at a rate that is greater than 120 percent at which the firm manufactured and/or imported portable generators during the base period. The base period is the average monthly manufacture or import volume for any continuous 180-day period within the last 12 months immediately preceding the month of promulgation of the final rule.