



United States  
**Consumer Product Safety Commission**

# Fatal Incidents Associated with Non-Fire Carbon Monoxide Poisoning from Engine-Driven Generators and Other Engine- Driven Tools, 2012–2022

Kathryn F. O'Connor  
U.S. Consumer Product Safety Commission  
Directorate for Epidemiology  
Division of Hazard Analysis  
4330 East West Highway  
Bethesda, MD 20814  
July 2023

*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.*

# Table of Contents

Executive Summary.....	4
Introduction.....	7
I. Reported Numbers of Fatalities by Engine-Driven Tool (EDT) Product Type .....	9
Table 1: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths Associated with Engine-Driven Tools, 2012–2022 .....	11
Table 2: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths.....	12
Associated with Engine-Driven Tools by Number of Deaths per Incident, 2012–2022 .....	12
Table 3: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths Associated with Engine-Driven Tools by Year, 2012–2022 .....	13
II. Socio-Demographic Characteristics of Victims and EDT-Use Patterns 2012-2022 .....	14
Table 4: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Age of Victim, 2012–2022 .....	14
Table 5: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Gender of Victim, 2012–2022 .....	15
Table 6: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Race/Ethnicity of Victim, 2012–2022 .....	16
Table 7: Number of Reported Non-Fire CO Incidents and Fatalities Associated with Engine-Driven Tools by Season, 2012–2022 .....	18
Table 8: Number of Reported Non-Fire CO Incidents and Fatalities Associated with Engine-Driven Tools by Victim Location, 2012–2022 .....	19
Table 9: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Population Density of Place of Death, 2012–2022.....	21
III. Alarm Usage 2012-2022 .....	22
Table 10: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire CO Poisoning Deaths, 2012–2022 .....	22
IV. Hazard Patterns Associated with Portable Generators 2012-2022 .....	23
Table 11: Number of Reported Non-Fire CO Fatalities for Incidents Associated with Generators <sup>1</sup> by Reason for Use, 2012–2022 .....	24
Table 12: Number of Reported Non-Fire CO Fatalities for Incidents Associated with Generators <sup>1</sup> by Reason for Power Outage, 2012–2022.....	25
Table 13: Non-Fire CO Poisoning Deaths in the Fixed-Structure Home Location <sup>1</sup> by Location of the Generator, <sup>2</sup> 2012–2022 .....	27
Table 14: Non-Fire CO Fatalities in the Fixed-Structure Home <sup>1</sup> Reported to CPSC Staff and Associated with Generators <sup>2</sup> Categorized by Status of Ventilation, 2012–2022.....	28
Table 15: Non-Fire CO Fatalities in the Fixed-Structure Home <sup>1</sup> Reported to CPSC Staff and Associated with Generators <sup>2</sup> Categorized by Size of Home, 2012–2022.....	29
Conclusions .....	29
References .....	31

**Appendix A: Epidemiology Data Retrieval Specifics..... 32**

**Appendix B: Engine Class of Generators Involved in Fatal CO Incidents..... 33**

**Table B-1: Engine Class of Generators Involved in Fatal CO Incidents, 2012–2022 ..... 34**

**Appendix C: Fatal CO Exposure Incidents Where Generator Was Located Outside the Victim Location..... 35**

**Table C-1: Fatal CO Generator Incidents Where the Generator Was Located Outside of the Occupied Space, 2012–2022 ..... 35**

**Appendix D: Carboxyhemoglobin Levels Present in CO Fatalities..... 37**

**Table D-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire CO Poisoning Deaths, 2012–2022<sup>1</sup> ..... 37**

**Appendix E: Historical Data..... 38**

**Figure 1: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools, 1999–2022 ..... 39**

# Executive Summary

This report summarizes fatal non-fire, carbon monoxide (CO) incidents associated with all engine-driven tools (EDTs), including portable generators and other engine-driven tools (OEDTs), that occurred in the 11-year period between 2012 and 2022, and were reported to U.S. Consumer Product Safety Commission (CPSC) staff as of April 17, 2023. Due to incident reporting delays, statistics for the most recent years (2021 and 2022) should be considered incomplete. Because data collection is ongoing, the numbers for these years most likely will increase in future reports.

Throughout this report, the number of deaths represents a count of the fatalities associated with generators and OEDTs (which include, but are not limited to, power lawn mowers, garden tractors, portable pumps, power sprayers and washers, snow blowers, and concrete saws) that were reported to CPSC. Portable generators are specifically reported because they represent the vast majority of the identified EDT incidents. The information on these fatalities is anecdotal and does not represent a complete set of all incidents that may have occurred during the relevant period. However, the information represents a minimum count for the number of CO-poisoning deaths associated with these products.

Additionally, included in this report are summaries of fatal, non-fire CO incidents in which one or more other fuel-burning consumer products<sup>1</sup> also may have been involved, and the EDT was believed to be at least a contributing factor to the fatal levels of CO. This report also provides a more detailed look at fatal, non-fire CO-poisoning incidents associated with EDTs.

Some of the findings of this report are summarized below:

## **CO Fatalities Associated with All EDTs and by EDT Product Type:**

- 872 fatalities from 699 incidents during 2012-2022;
  - 749 fatalities (86%) from 583 incidents associated with generators *only*;
  - 81 fatalities (9%) from 81 incidents involved OEDTs *only*; and
  - 42 fatalities (5%) from 35 incidents involved *multiple* fuel-burning consumer products, in which one product was an EDT and the other product was a non-EDT.
    - In 33 of those incidents involving multiple consumer products, the second product involved was heating equipment (portable liquid propane- or kerosene-fueled, or an electric heater being powered by a generator), or a cooking product. In one incident, the second source of carbon monoxide was a burning firewood log.

---

<sup>1</sup> Combustion consumer products produce heat or energy by burning a fuel source. All fuel-burning consumer products may produce gases that contain CO, because CO is a by-product of incomplete combustion.

- 41 fatalities from 34 separate incidents in 2022 as of the reporting deadline; 34 deaths (83%) from 28 incidents associated with generators alone.
- Compared to the 2022 report, this report presents
  - 36 additional fatalities in 2021; and
  - 3 additional fatalities in 2020.

**Socio-Demographic Characteristics of Victims and EDT-Use Patterns (2012-2022):**

- Age: 87 percent of portable generator-related decedents and all 100 percent of OEDT-related decedents were 25 years old or older.
- Gender: 78 percent of portable generator-related decedents and 100 percent of the OEDT-related decedents were males.
- Race/Ethnicity: 23 percent of portable generator-related decedents where race was known were non-Hispanic Black or African Americans, which is much higher than their share in the U.S. population. Non-Hispanic White Americans constituted 92 percent of OEDT-related decedents where race was known, which is also much higher than their share in the U.S. population.
- Seasonal effects: 45 percent of fatalities from EDTs happen during the four colder months of the year (November through February); 32 percent during the transition months (March, April, September, and October); and 23 percent in the warmer months.
- Structure type: 68 percent of all EDT-related fatalities occurred at fixed-structure homes.
- Urban versus rural: 56 percent of all EDT-related fatalities occurred in urban areas, and 16 percent occurred in small, rural, and isolated areas, a much greater proportion of the U.S. population than the population of individuals who live in rural and isolated areas.

**CO Alarm Usage (2012-2022):**

- A CO alarm: Only 33 (4%) of all EDT-related fatalities were associated with incidents in which an alarm was known to be present on the premises.
  - For 17 of the deaths where an alarm was present, the alarm was inoperable, due to no batteries, batteries inserted incorrectly, possibly drained batteries, no electric current, or the alarm did not sound for some unknown reason.
  - For 13 of the deaths, the alarm sounded, but the signal was misunderstood, the alarm was subsequently disarmed, or the alarm sounded inside the house, while the fatality occurred inside an attached garage.
  - For 4 deaths, staff does not know if the alarm sounded during the event.

**Hazard Patterns Associated with Generators (2012-2022):**

- The three most common reasons for using generators among reported incidents are power outages, power shut-offs, and attempts to provide power to temporary locations, such as cabins, campers, and trailers.
  - Power outages: 103 incidents with 139 fatalities. Mostly for weather-related issues, such as ice/snow storms and hurricanes/tropical storms.

- Power shut-offs: 86 incidents involving 117 fatalities.
- Power to temporary locations: 114 incidents with 139 fatalities.
- The most common locations with generator-related fatalities were residential locations, accounting for 77 percent of the generator-related CO fatalities.
  - Fixed-structure homes: 553 non-fire CO fatalities (414 incidents). The incidents involved a generator or, to a lesser extent, a generator in use with another potential CO-generating consumer product, mostly placed inside the living area of the home.
    - In 66 percent of these fatalities for which information was available, no apparent ventilation of the generator exhaust was attempted.
    - Approximately the same percentage of the incidents for which information was available (64 percent) occurred in houses less than 1,500 square feet in size.
- Generator located outdoors: In 5 percent of generator-related fatalities the associated generator was outdoors (see Appendix C). In these incidents, the generator was situated close enough to windows, air conditioners, or other locations, to allow CO to infiltrate an enclosed space. In one case, the victim was outside, close to the running generator and did not survive. In 2021, a 3-person fatality incident involved a CO shutoff-equipped generator that was advertised as certified to the voluntary standard *ANSI/PGMA G300-2018, Safety and Performance of Portable Generators*. In this incident, it was reported that the generator was outside of the home, under the eaves that had soffit vents into the attic, with windows and doors locked closed. The exhaust pointed towards one of the closed exterior doors; the generator did not shut off and ran until the gas tank was empty.

**Engine Class of Generators Involved in Fatal CO Incidents (2012-2022):**

- Of the 616 fatal generator incidents between 2012 and 2022 (including the generator plus non-EDT category), the generator engine class could only be determined in 251 cases. Ninety-five percent of the 251 incidents involved a portable generator with a Class I engine (89 incidents) or Class II, Single-Cylinder engine (149 incidents). (See Appendix B for engine class definition.)

**Carboxyhemoglobin Levels in CO Fatality Victims (2012-2022):**

- Of the CO fatalities associated with EDTs, in 83 percent the victims had carboxyhemoglobin (COHb) levels at or above the 50 percent level, when the COHb level was known.<sup>2</sup>

*Note: Throughout this report, the years 2021 and 2022 are italicized in table headings, indicating that incident and death counts are likely to change as additional information is*

---

<sup>2</sup> As levels rise above 40 percent COHb, death is possible in healthy individuals, and it becomes increasingly likely with prolonged exposures that maintain levels in the 40 percent to 60 percent range.

*received. Incident and death counts may change for other years, as well, but to a much smaller extent.*

## Introduction

CPSC staff searched the Consumer Product Safety Commission Risk Management System (CPSRMS) databases to prepare the statistics recorded in this report. See Appendix A for the codes and keywords used in the database searches. The data records were combined and collated to develop the most complete set of records possible in a single database. At this stage, staff reviewed each record to determine whether the incident was in-scope for this report and to correct any discrepancies in information from the different sources (see Appendix A for the specifics of scope determination). It should be noted that reporting may not be complete, and this report reflects only incidents reported and entered into CPSC databases on or before April 17, 2023. Staff included all fatal, unintentional, non-fire carbon monoxide (CO) incidents associated with engine-driven tools (EDTs) found during the database search that were determined to be in-scope incidents.

CPSC records contain information on 872 non-fire CO fatalities associated with EDTs during the years 2012 through 2022. Last year's report, dated June 2022, contained summary information and analyses for the 11-year period 2011–2021. In addition to dropping year 2011 from the reporting period, this updated report added information on 80 additional CO fatalities associated with engine-driven tools.

Changes to previous report:

- 2020 – 3 new incidents added, accounting for 3 deaths.
- 2021 – 33 new incidents added, accounting for 36 deaths.
- 2022 – 34 new incidents added, accounting for 41 deaths.

Incidents associated with generators that were specifically reported as integral parts of recreational vehicles (RVs), motor homes, or boats are generally not within the jurisdiction of the CPSC. Thus, these incidents were considered out of scope and were not included. For example, generators that were reportedly mounted to an RV by the RV manufacturer were not included; nor were boat generators that were installed by the boat manufacturer. Because incidents in recreational vehicles and boats can be associated with a portable generator or an integral generator, those incidents in which the type of generator could not be determined were also excluded from the analysis. Any incident that was reported to be intentional in nature was considered to be out of scope and was also excluded from the analysis, as were work-related incidents, which are generally not within the jurisdiction of the CPSC.

This report is divided into four sections:

- I. Reported Numbers of Fatalities by EDT Product Type. This presents an overall picture of CO fatalities associated with engine-driven tools.

- II. Socio-Demographics of Victims and EDT Use Patterns. This presents various socio-demographic summaries focused on identifying specific characteristics of CO fatality victims and usage patterns, such as when and where fatalities occurred.
- III. Alarm Usage. This presents information on CO alarm usage during fatal CO events.
- IV. Hazard Patterns Associated with Generators. This presents data specific to portable generator usage patterns that may lead to fatal CO poisoning events.

Additionally, there are five appendices:

- Appendix A presents the database search criteria;
- Appendix B presents the generator-size class distribution involved in the fatal CO incidents;
- Appendix C presents a summary of fatal CO incidents that occurred with the generator located in outdoor locations;
- Appendix D presents summary findings on carboxyhemoglobin (COHb) levels in the blood of victims of CO poisoning involving EDT use, which are helpful in assessing the hazard presented by the product and the speed of onset of harm; and
- Appendix E graphically presents the year-by-year summary of CO fatalities broken out separately by generators and OEDTs for the years 1999 through 2022.

# I. Reported Numbers of Fatalities by Engine-Driven Tool (EDT) Product Type

Table 1 presents the reported fatal incidents and the number of deaths in 2012 through 2022, along with a revised summary of CO incidents and fatalities associated with engine-driven tools from 2020 through 2022. The table records the number of incidents and deaths by the broad categories of “Generators,” “OEDT,” and “Multiple Products.” Within each broad category, the frequency of reports is summarized by product type. Staff is aware of 699 incidents involving EDTs, with a total of 872 deaths due to non-fire CO exposure that occurred between 2012 and 2022. For calendar year 2022 alone, as of April 17, 2023, 41 deaths were reported to have occurred due to non-fire CO exposure incidents involving EDTs. These 41 deaths due to CO occurred in 34 separate incidents.

CPSC staff is aware of 41 fatalities associated with multiple consumer products occurring in the period 2012 through 2022. Multiple product incidents are either fatal CO poisonings that involved fuel-burning consumer products of different types that generate CO, with at least one product being an EDT, or incidents where the investigating authorities could not determine which of the multiple consumer products in use was the source of the CO. By this definition, incidents involving multiple consumer products of the same type (e.g., 2 lawn mowers) were not classified in the “Multiple Products” category. To ensure there is not overcounting, incidents in which multiple CO-producing products were involved, where at least one of the sources of CO is not under the CPSC’s jurisdiction, such as automobiles, boats, or recreational vehicles, were treated as out of scope, and they are not included in this report. Thus, this report may underestimate the incidents of CO fatalities. For the rest of the report after Table 1, “Multiple Products” incidents are included in the summary for the involved engine-driven tool type, either Generators or OEDTs.

In Table 1, the product type, “Welder,” appears in both the Generator and OEDT categories, and incidents involving welding equipment are divided between these two categories. This is because some welding equipment is designed to be used as either a welder or an electric generator. Three of the five fatal, non-fire CO incidents from 2012-2022 associated with the use of welding equipment involved use as a generator to provide power to a location. In 2020, one such incident killed four individuals. The remaining two fatal, non-fire CO incidents (two fatalities) involved the use of welding equipment, and did not specifically identify that the welder was being used as a generator.

Of the 42 non-fire CO fatalities in the “Multiple Products” category for 2012–2022, 40 of them involved a heating- or cooking-related consumer product in addition to an EDT. All cooking-related consumer products appear to have been in use as a makeshift heating product.

In one incident in 2021, the second product involved was a partially burned log found near the victim. It was not reported whether this was a natural firewood log or a chemically

treated starter log. It is included in the “Multiple products” category because the log was reportedly a secondary source of CO, although it is unclear whether the log was a type that would be a consumer product.

In addition, during 2012-2022, there was a fatal incident in which two generators and an LP heater were in use; this incident is included as a generator- and heater-associated fatality in Table 1. In addition, among eight fatal incidents (nine deaths) that may have involved more than one generator (either known by officials to be in use or identified by officials as possibly in use), one incident included the possible use of three generators.

**Table 1: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths  
Associated with Engine-Driven Tools, 2012–2022**

Product	2020		2021		2022		Total: 2012–2022	
	Number of Incidents	Number of Deaths						
<b>Total Engine-Driven Tools</b>	<b>85</b>	<b>111</b>	<b>72</b>	<b>88</b>	<b>34</b>	<b>41</b>	<b>699</b>	<b>872</b>
<b>Generators</b>	<b>70</b>	<b>95</b>	<b>68</b>	<b>84</b>	<b>28</b>	<b>34</b>	<b>583</b>	<b>749</b>
Generator, portable	69	91	68	84	29	35	579	742
Generator, fixed location	0	0	0	0	0	0	1	1
Welder (used as a generator) <sup>1</sup>	1	4	0	0	0	0	3	6
<b>Other Engine-Driven Tools (OEDT)</b>	<b>7</b>	<b>7</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>81</b>	<b>81</b>
Lawn mowers	5	5	2	2	1	1	41	41
Riding lawn mower/Garden tractor	4	4	2	2	0	0	27	27
Powered push lawn mower	0	0	0	0	0	0	1	1
Powered lawn mower, unspecified type	1	1	0	0	1	1	13	13
Snow blower	1	1	0	0	1	1	9	9
Power washer/sprayer	1	1	0	0	1	1	11	11
All-terrain vehicle	0	0	0	0	0	0	5	5
Welder (used as welder or other reason) <sup>1</sup>	0	0	0	0	0	0	2	2
Water pump / Sump pump	0	0	0	0	0	0	3	3
Concrete saw	0	0	1	1	0	0	2	2
Wood Splitter	0	0	0	0	0	0	2	2
Stump Grinder	0	0	0	0	0	0	1	1
Leaf Blower	0	0	0	0	0	0	2	2
Antique Tractor	0	0	0	0	0	0	1	1
Unspecified Gas Power Equipment	0	0	0	0	0	0	2	2
<b>Multiple Products<sup>2</sup></b>	<b>8</b>	<b>9</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>35</b>	<b>42</b>
Generator + Other Consumer Product	8	9	1	1	2	3	33	40
OEDT + Other Consumer Product	0	0	0	0	1	1	2	2

1 Some welding equipment is designed to be used as a welder or a generator; actual use is reflected here.

2 “Multiple Products” includes incidents involving generators or OEDTs with other combustion fuel-burning consumer products. “Other Consumer Products” includes one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves. This includes one 2021 incident involving a generator and a partially burned log inside an enclosed detached shed.

Note: Italicized numbers indicate that reporting of incidents for 2021 and 2022 is ongoing. Counts may change in subsequent reports.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Five hundred and eighty-three of the 699 incidents (83%) reported to CPSC staff during the 2012–2022 period were associated with a generator alone, and the incidents accounted for 749 of the 872 CO deaths (86%). Additionally, 40 other CO fatalities from 33 incidents were associated with the use of a generator and another combustion consumer product—most commonly an LP- or kerosene-fueled heater. Because the majority of the reported EDT incidents were associated with generators, and the number of these incidents is so large, characteristics of these incidents are reported separately in Section IV.

For the remaining incidents, nearly half of the OEDT CO incidents (49%, 41 of 83) involved a garden tractor or other powered lawn mower (including one “Multiple Products” incident involving a tractor and an LP grill). Deaths associated with powered lawn mowers were often associated with an individual repairing or otherwise working on the product in an enclosed space. Additionally, there was one fatal incident in which a consumer was apparently repairing an antique tractor in his garage. Due to the relatively small number of non-generator, engine-driven tool CO fatalities, throughout the remainder of this report, these incidents are collectively reported as “OEDT-related.”

CPSC staff examined the number of deaths associated with each fatal incident (Table 2). Of the 699 fatal incidents, 82 percent involved a single fatality. Seventy-nine percent (487 of 616) of the fatal generator-related incidents involved a single fatality. One incident in 2015, which involved a generator, resulted in the deaths of eight people (a father and his seven children). In 2016, another incident, involving an LP-fueled generator, resulted in six deaths. Of the 83 fatal incidents in the OEDTs category, all the incidents resulted in no more than one fatality.

**Table 2: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths Associated with Engine-Driven Tools by Number of Deaths per Incident, 2012–2022**

Number of Deaths Reported per Incident <sup>1</sup>	All Engine-Driven Tools (EDTs) Incidents		Generator Incidents		Other Engine-Driven Tools (OEDTs) Incidents	
	Count	Percentage	Count	Percentage	Count	Percentage
	<b>699</b>	<b>100%</b>	<b>616</b>	<b>100%</b>	<b>83</b>	<b>100%</b>
1	570	82%	487	79%	83	100%
2	104	15%	104	17%	0	0%
3	13	2%	13	2%	0	0%
4	9	1%	9	1%	0	0%
5	1	< 1%	1	< 1%	0	0%
6	1	< 1%	1	< 1%	0	0%
7	0	0%	0	0%	0	0%
8	1	< 1%	1	< 1%	0	0%

Notes: Totals may not add to 100 percent due to rounding. Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

CPSC staff also summarized the number of reported deaths associated with EDTs by year of death (Table 3). It should be noted that the values in Table 3 represent the number of deaths reported to CPSC staff as of April 17, 2023. Some deaths are reported to CPSC staff shortly after an incident occurs, while other deaths are reported to CPSC staff months, or even years, after an incident occurs. Therefore, counts for more recent years may not be as complete as counts for earlier years and may change in the future. Since 2012, prior year counts have increased by an average of 51 percent in the following year's report and by an additional average of 6 percent 2 years later. Over the last 3 years, the rate has been even higher, at an 81 percent average increase in report counts the following year. This may be due to delays in reporting associated with the COVID-19 pandemic.

The average number of non-fire CO fatalities associated with generators and OEDTs for years 2018 through 2020, is also presented in Table 3. Although slight changes are still possible in the future, these 3 years represent the most recent years for which CPSC staff believes reporting is substantially complete. Figure 1 in Appendix D illustrates the historical trend in EDT-related, non-fire CO fatalities since 1999.

**Table 3: Number of Reported Fatal Non-Fire CO Exposure Incidents and Deaths Associated with Engine-Driven Tools by Year, 2012–2022**

Year	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths
<b>Total</b>	<b>699</b>	<b>87</b>	<b>616</b>	<b>789</b>	<b>83</b>	<b>83</b>
2012	48	54	43	49	5	5
2013	56	69	46	59	10	10
2014	45	56	38	49	7	7
2015	59	84	52	77	7	7
2016	67	85	57	75	10	10
2017	75	91	67	83	8	8
2018	69	88	57	76	12	12
2019	89	105	79	95	10	10
2020	85	111	78	104	7	7
2021	72	88	69	85	3	3
2022	34	41	30	37	4	4
<b>Average: 2018–2020</b>	<b>81</b>	<b>101</b>	<b>71</b>	<b>92</b>	<b>10</b>	<b>10</b>

Notes: Detail averages may not sum to total average due to rounding. Italicized numbers for 2021 and 2022 indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

## II. Socio-Demographic Characteristics of Victims and EDT-Use Patterns 2012-2022

This section presents socio-demographic information about the victims of reported fatal CO incidents associated with EDTs. Tables 4, 5, and 6 summarize socio-demographic characteristics of the victims. Table 4 presents the distribution of ages of the victims.

According to the U.S. Census's 2019 5-Year Estimated U.S. Resident Population figures (the approximate mid-point range of this data summary), approximately 68 percent of the U.S. population is over the age of 24 years. In comparison, 88 percent (769 of 872) of reported non-fire, CO poisoning decedents associated with all EDTs, 87 percent (686 of 789) of decedents associated with generators, and all of the 83 decedents associated with OEDTs, were 25 years or older. In fact, 83 percent of the non-fire CO fatalities associated with OEDTs (69 of 83) involved victims age 45 or older.

It appears from the data summary that all EDT-related CO fatalities have involved older consumers at a higher rate than younger consumers, relative to their respective proportion in the general U.S. population. Specifically, 60 percent of the CO fatalities were to victims over the age of 44, while only 42 percent of the U.S. population was above 44 years of age during this period. By contrast, only 12 percent of EDT-related victims were below the age of 25, while 32 percent of the U.S. population was below 25 years of age during this period. Additionally, 5% of generator incidents were associated with child fatalities; there were 40 victims under the age of 15 from 2012-2022. Of these, 36 fatalities occurred in a fixed-structure home.

**Table 4: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Age of Victim, 2012–2022**

Age	2019 5-Year Estimated U.S. Resident Population <sup>1</sup>	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
		Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>Total</b>	<b>100%</b>	<b>872</b>	<b>100%</b>	<b>789</b>	<b>100%</b>	<b>83</b>	<b>100%</b>
Under 5	6%	7	1%	7	1%	0	0%
5–14	13%	33	4%	33	4%	0	0%
15–24	13%	62	7%	62	8%	0	0%
25–44	26%	250	29%	236	30%	14	17%
45–64	26%	352	40%	321	41%	31	37%
65 and over	16%	167	19%	129	16%	38	46%
Unknown	--	1	<1%	1	<1%	0	0%

<sup>1</sup> This percentage represents the 2015-2019 Census-estimated percentage of the U.S. population, an approximate mid-point range of the 11-year range.

Note: Totals may not add to 100 percent due to rounding.

Sources: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Table 5 presents the distribution of the gender of the victims. Male victims accounted for 80 percent of the deaths associated with all EDTs. Male victims comprised 78 percent of the deaths associated with generators and 100 percent of OEDT fatalities.

**Table 5: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Gender of Victim, 2012–2022**

Gender	2019 5-Year Estimated U.S. Resident Population <sup>1</sup>	All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)	
		Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>Total</b>	<b>100%</b>	<b>872</b>	<b>100%</b>	<b>789</b>	<b>100%</b>	<b>83</b>	<b>100%</b>
Male	49%	696	80%	613	78%	83	100%
Female	51%	176	20%	176	22%	0	0%

<sup>1</sup> This percentage represents the 2015-2019 Census-estimated percentage of the U.S. population, an approximate mid-point range of the 11-year range.

Notes: Totals may not add to 100 percent due to rounding.

Sources: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

5-Year Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: January 1, 2015 to December 31, 2019.

Table 6 summarizes the race/ethnicity of the reported CO fatalities associated with EDTs. The structure of this table has been updated from previous years to align with other CPSC reports.

The percentage of generator-related CO fatalities identified as non-Hispanic “Black/African American” (23% of deaths) was much higher than the percentage of individuals in the U.S. population classified by the U.S. Census Bureau as non-Hispanic “Black/African Americans” (an estimated 12%). The percentage of the OEDT-related CO fatalities identified as non-Hispanic “White” (92% of deaths) was also much higher than the proportion of the U.S. population classified as non-Hispanic “White” by of the U.S. Census Bureau (an estimated 61%). It should be noted that race/ethnicity determinations are based on available information. Many of the race/ethnicity determinations are based on death certificate data. However, some states do not provide this information on the death certificate and, barring other available information, these individuals were designated as “Unknown”. Additionally, some individuals were identified as “mixed” or “multiple” as a race/ethnicity designation. Some individuals were simply designated as “Other”. Individuals falling into these designations were combined into the “Other/Multiple” category. Finally, some individuals were identified as “Hispanic” with no other race information, or a race which did not fall into another category; these individuals are categorized as “Hispanic – Other/Multiple” in the table below.

**Table 6: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Race/Ethnicity of Victim, 2012–2022**

Ethnicity	Race	2019 5-Year Estimated U.S. Resident Population <sup>1</sup>	All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)	
			Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>All</b>	<b>Total Known</b>	<b>100%</b>	<b>824</b>	<b>100%</b>	<b>747</b>	<b>100%</b>	<b>77</b>	<b>100%</b>
	White <sup>3</sup>	72%	588	71%	517	69%	71	95%
	Black	13%	180	22%	176	24%	4	5%
	Asian	6%	15	2%	15	2%	0	0%
	American Indian/Alaska Native	< 1%	12	1%	12	2%	0	0%
	Native Hawaiian/Pacific Islander	< 1%	1	< 1%	1	< 1%	0	0%
	Other/Multiple	8%	28	3%	26	3%	2	3%
<b>Hispanic</b>	<b>Total</b>	<b>18%</b>	<b>114</b>	<b>14%</b>	<b>112</b>	<b>15%</b>	<b>2</b>	<b>3%</b>
	White	12%	86	10%	86	12%	0	0%
	Black	< 1%	2	< 1%	2	< 1%	0	0%
	Asian	< 1%	0	0%	0	0%	0	0%
	American Indian/Alaska Native	< 1%	0	0%	0	0%	0	0%
	Native Hawaiian/Pacific Islander	< 1%	0	0%	0	0%	0	0%
	Other/Multiple	6%	26	3%	24	3%	2	3%
<b>Non-Hispanic</b>	<b>Total</b>	<b>82%</b>	<b>710</b>	<b>86%</b>	<b>635</b>	<b>85%</b>	<b>75</b>	<b>97%</b>
	White	61%	502	61%	431	58%	71	92%
	Black	12%	178	22%	174	23%	4	5%
	Asian	5%	15	2%	15	2%	0	0%
	American Indian/Alaska Native	< 1%	12	1%	12	2%	0	0%
	Native Hawaiian/Pacific Islander	< 1%	1	< 1%	1	< 1%	0	0%
	Other/Multiple	3%	2	< 1%	2	< 1%	0	0%
<b>Unknown</b>	<b>Unknown</b>	<b>-</b>	<b>48</b>	<b>-</b>	<b>42</b>	<b>-</b>	<b>6</b>	<b>-</b>

1 This percentage represents the 2015-2019 Census-estimated percentage of the U.S. population, an approximate mid-point range of the 11-year range.

2 These are percentages of deaths where race is known.

3 These Race/Ethnicity designations are for single race only.

Notes: Totals may not add to 100 percent due to rounding.

Sources: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

5-Year Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: January 1, 2015 to December 31, 2019.

Staff examined reported deaths associated with EDTs by the time of year that the incident occurred (Table 7). The non-fire CO fatalities were classified into one of three categories, depending on the month in which the incident occurred: cold months, warm months, and transitional months. “Cold months” are November, December, January, and February; “warm months” are May, June, July, and August; and “transitional months” are March, April, September, and October.

Through the 11 years covered by this report, non-fire CO deaths associated with EDTs have tended to occur more often in the four colder months of the year (November through February) than in others. Forty-six percent of the incidents (45% of fatalities) of the non-fire CO deaths associated with EDTs occurred in these months. Many of the fatalities can be directly associated with the use of generators during power outages because of weather conditions, such as ice or snow storms. Thirty-two percent of the EDT-related CO deaths occurred in the transitional months. A large portion of the non-fire CO fatalities in the transitional months can be directly associated with the use of generators during power outages because of hurricanes and tropical storms, with many occurring in September and, to a lesser extent, in October. Additional details on this data are presented in Section IV of this report.

**Table 7: Number of Reported Non-Fire CO Incidents and Fatalities Associated with Engine-Driven Tools by Season, 2012–2022**

Season Incident Occurred		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	Incidents	699	100%	616	100%	83	100%
	Deaths	872	100%	789	100%	83	100%
Cold months	Incidents	326	47%	286	46%	40	48%
	Deaths	391	45%	351	44%	40	48%
Transitional months	Incidents	224	32%	199	32%	25	30%
	Deaths	281	32%	256	32%	25	30%
Warm months	Incidents	149	21%	131	21%	18	22%
	Deaths	200	23%	182	23%	18	22%

Notes: Totals may not add to 100 percent due to rounding.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Incidents involving deaths are described further in Table 8 by the location where the death occurred. The majority of non-fire, CO poisoning deaths associated with EDTs (686 of 872, or 79%) were reported to have occurred at residential locations, which include fixed-structure homes, apartments, and detached structures located at a residence, like detached garages and sheds. Sixty-eight percent of the deaths occurred at fixed structures used as a residence, which includes houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage. Another 10 percent occurred in external or detached structures at home locations, such as detached garages or sheds. A larger portion of these external structure fatalities were related to OEDTs, such as lawnmowers running in sheds or detached garages. For example, 41 percent of OEDT-related fatalities occurred in external structures at home locations, while only 7 percent of generator-deaths occurred there.

Eight percent of deaths associated with EDTs occurred in RVs and camper trailers. The “RV/Camper trailer” category was added this year to better reflect the large portion of fatalities associated with RVs and trailers. In previous years, RVs and trailers were split according to whether they were being used permanently, temporarily, or for some other reason. However, due to the availability of information, the nature of use is sometimes impossible to discern. Thus, the categorization of RVs and camper trailers was simplified this year.

The “RV/Camper trailer” and “Boat/Vehicle” categories only include incidents in which an EDT was not an integral part of the boat/vehicle/camper, but was instead brought on as a portable power source. Incidents that involved built-in generators, or generators built specifically for use in an RV, generally are not within the CPSC’s jurisdiction, and as such, have been excluded from the analyses. However, one 2018 fatality that involved a portable generator retrofitted into an RV generator compartment was included because it involved what was originally a portable generator. In addition, two fatalities resulting from a 2018

incident on a boat, where the consumers connected a portable generator inside the engine compartment of the boat, were included because the generator was a portable generator that was retrofitted for use on the boat.

The “Cabin/Remote structure” category includes locations such as hunting cabins, sheds, and other fixed structures located on otherwise vacant or non-residential lots. The “Other enclosed space” category includes incidents that occurred in locations such as office buildings, utility buildings, shipping/storage containers, tents, and other enclosed spaces which do not fall under any other category.

**Table 8: Number of Reported Non-Fire CO Incidents and Fatalities Associated with Engine-Driven Tools by Victim Location, 2012–2022**

Victim Location		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	Incidents	699	100%	616	100%	83	100%
	Deaths	872	100%	789	100%	83	100%
Home, fixed structure <sup>1</sup>	Incidents	458	66%	414	67%	44	53%
	Deaths	597	68%	553	70%	44	53%
Home, detached structure <sup>2</sup>	Incidents	88	13%	54	9%	34	41%
	Deaths	89	10%	55	7%	34	41%
Cabin/Remote structure <sup>3</sup>	Incidents	9	1%	9	1%	0	0%
	Deaths	12	1%	12	2%	0	0%
RV/Camper Trailer	Incidents	54	8%	54	9%	0	0%
	Deaths	68	8%	68	9%	0	0%
Boat/Auto	Incidents	33	5%	33	5%	0	0%
	Deaths	36	4%	36	5%	0	0%
Other enclosed space	Incidents	48	7%	43	7%	5	6%
	Deaths	61	7%	56	7%	5	6%
Outdoors	Incidents	2	< 1%	2	< 1%	0	0%
	Deaths	2	< 1%	2	< 1%	0	0%
Not reported	Incidents	7	1%	7	1%	0	0%
	Deaths	7	< 1%	7	< 1%	0	0%

1 This refers to a fixed-structure used as a residence, including: houses, mobile homes, apartments, townhouses, and structures attached to the house, such as attached garages.

2 This refers to detached structures at home locations, including detached garages and sheds.

3 This refers to cabins, sheds, and other fixed structures on otherwise vacant lots.

Notes: Totals may not add to 100 percent due to rounding.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Table 9 presents the number of non-fire, CO poisoning deaths reported to CPSC staff that were associated with EDTs, categorized by the population density of the place of death. All fatal incidents were assigned to one of four rural/urban categories, based on the Rural-

Urban Commuting Area (RUCA) codes developed by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA). The four categories are “Urban Core,” “Sub-Urban,” “Large Rural,” and “Small Rural/Isolated.” Details on the process of determining population density or rurality can be found at the USDA website at: <http://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx>. Additional information regarding the cross-referencing of zip codes to RUCA codes can be obtained from the University of Washington, WWAMI<sup>3</sup> Rural Health Research Center website at: <http://depts.washington.edu/uwruca/>. This study is updated approximately once every 10 years, the last update occurring in 2010; but revisions were made on July 3, 2019, to correct a programming error affecting the 2010 secondary RUCA codes.

Fifty-six percent (488 of 872) of CO fatalities associated with the use of EDTs reported to CPSC staff occurred in urban areas, while the estimated proportion of the U.S. population living in urban core areas is 71 percent. The remaining 44 percent (384 of 872) of CO fatalities occurred in non-urban core areas (sub-urban, large rural, and small rural/isolated areas), where an estimated 29 percent of the U.S. population lives. The proportions of fatalities for each of the lower density locations therefore exceeds each of proportions of the U.S. population who live in these locations.

---

<sup>3</sup> The WWAMI name is derived from the first letter of each of the five cooperating states in a partnership between the University of Washington School of Medicine and the states of Wyoming, Alaska, Montana, and Idaho.

**Table 9: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools by Population Density of Place of Death, 2012–2022**

Population Density		Estimated Percentage of U.S. Population <sup>1</sup>	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	Incidents	100%	699	100%	616	100%	83	100%
	Deaths		872	100%	789	100%	83	100%
Urban Core	Incidents	71%	387	55%	349	57%	38	46%
	Deaths		488	56%	450	57%	38	46%
Sub-Urban	Incidents	10%	103	15%	81	13%	22	27%
	Deaths		134	15%	112	14%	22	27%
Large Rural	Incidents	10%	88	13%	77	13%	11	13%
	Deaths		103	12%	92	12%	11	13%
Small Rural /Isolated	Incidents	9%	116	17%	104	17%	12	14%
	Deaths		140	16%	128	16%	12	14%
Unknown	Incidents	-	5	< 1%	5	< 1%	0	-
	Deaths		7	< 1%	7	< 1%	0	-

<sup>1</sup> Percentages are determined from the estimated 2010 U.S. population categorized by RUCA designation. U.S. population estimates by RUCA classification were determined by cross-referencing the WWAMI RUCA zip code table with the 2010 U.S. Census population estimates by zip code area, the most current census data available by zip code area. USDA updates the RUCA tables once every 10 years. The tables for the year 2010 are the most up-to-date.

Notes: Totals may not add to 100 percent due to rounding.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

United States Department of Agriculture, Economic Research Service, 2019.

WWAMI Rural Research Center at the University of Washington Economic Research Group, USDA.

U.S. Census Bureau, 2011.

### III. Alarm Usage 2012-2022

Table 10 presents a summary of CO fatalities characterized by CO alarm usage and alarm status. The available incident reports contain limited information on CO alarm usage. In 76 percent of the fatal incidents (533 of 699) and 74 percent of reported CO poisoning deaths (648 of 872), the presence of a CO alarm at the location of the incident was unknown or unreported. Of the 118 fatal incidents (172 CO fatalities) associated with EDTs in which it was known whether a CO alarm was present, a CO alarm was present in only 25 incidents (21%) involving 33 CO fatalities. Of these 25 fatal incidents, the alarm was known to have sounded a warning in only 10 cases (12 fatalities). In most cases, it was either unknown if the alarm sounded before the victims were incapacitated or if they ignored it. Also, there are cases where the alarm sounded inside the house with the victim located in the garage. In these cases, it is most likely that the victims were incapacitated prior to the CO seeping into the house to a level that the alarm would activate.

**Table 10: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire CO Poisoning Deaths, 2012–2022**

CO Alarm Status	Number of Deaths and Percentage of Deaths when Alarm Status was Known								
	All Engine-Driven Tools (EDTs)			Generators			Other Engine-Driven Tools (OEDTs)		
	Incidents	Deaths	% of Deaths	Incidents	Deaths	% of Deaths	Incidents	Deaths	% of Deaths
<b>Total</b>	<b>699</b>	<b>872</b>	<b>-</b>	<b>616</b>	<b>789</b>	<b>-</b>	<b>83</b>	<b>83</b>	<b>-</b>
<b>Alarm Status Known</b>	<b>118</b>	<b>172</b>	<b>100%</b>	<b>105</b>	<b>159</b>	<b>100%</b>	<b>13</b>	<b>13</b>	<b>100%</b>
<b>No Alarm</b>	<b>93</b>	<b>139</b>	<b>81%</b>	<b>86</b>	<b>132</b>	<b>83%</b>	<b>7</b>	<b>7</b>	<b>54%</b>
<b>Alarm Present</b>	<b>25</b>	<b>33</b>	<b>19%</b>	<b>19</b>	<b>27</b>	<b>17%</b>	<b>6</b>	<b>6</b>	<b>46%</b>
Alarmed	10	12	7%	6	8	5%	4	4	31%
Did not alarm, batteries removed, incorrectly inserted, or drained	9	14	8%	9	14	9%	0	0	0%
Did not alarm, plug-in type, no power	1	2	1%	1	2	1%	0	0	0%
Alarm present, Unknown if it Alarmed	4	4	2%	2	2	1%	2	2	15%
Did not alarm, Unknown reason	1	1	< 1%	1	1	< 1%	0	0	0%
<b>Not applicable<sup>1</sup></b>	<b>48</b>	<b>52</b>	<b>-</b>	<b>46</b>	<b>50</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>-</b>
<b>Alarm Status Unknown</b>	<b>533</b>	<b>648</b>	<b>-</b>	<b>465</b>	<b>580</b>	<b>-</b>	<b>68</b>	<b>68</b>	<b>-</b>

<sup>1</sup> This category refers to incidents where the victim was found in a location which would not be suited or expected to have a CO alarm, such as: outdoors, tents, shipping or storage containers, passenger vehicles, or other environments not suited to alarms.

Notes: Totals may not add to 100 percent due to rounding.

## IV. Hazard Patterns Associated with Portable Generators 2012-2022

By a wide margin the EDTs most often involved in CO poisoning incidents are portable generators. To better understand this dominant scenario in the EDT incidents, this section presents information about the usage patterns associated with fatal CO poisonings specific to generators, as well as information about the homes in which fatal generator incidents occurred. As of April 17, 2023, CPSC staff is aware of 616 generator-related incidents from 2012 through 2022, which resulted in non-fire CO fatalities. Thirty-four of these incidents may have also involved a second fuel-burning device that may have contributed to the CO poisonings. Staff completed, or otherwise resolved, in-depth investigations (IDIs) for 575 of 616 (93%) fatal CO incidents associated with generators that occurred from 2012 through 2022. For the remaining 40 incidents for which there was not a complete IDI by the cut-off date of April 17, 2023, attempts were made to augment the data from reports of the incidents from other sources, such as death certificates. Summaries of generator-related incidents in this section also include incidents in which multiple, fuel-burning consumer products were involved, including a generator.

A review of records for the 616 incidents resulting in 789 generator-related, non-fire CO deaths reported to CPSC staff suggests three primary reasons for using a generator. One was to provide electricity to a location temporarily during a power outage or other situation preventing normal power use. A second primary reason was to provide power after a shutoff to the residence by the utility company, due to a bill dispute or nonpayment. The third primary reason was to provide power to a temporary location, such as a camper or a cabin. Table 11 provides a breakdown, by year, listing the reasons why a generator was in use at the time of the incident. Seventeen percent of the incidents (18 percent of the reported deaths) involving generator-related, non-fire CO fatalities were associated with a temporary power outage stemming from a weather problem, or a problem with power distribution. Fourteen percent of the fatal incidents (15 percent of deaths) were associated with a power shutoff by the utility company. Additionally, 19 percent of incidents (18 percent of deaths) were associated with attempting to provide power to temporary locations, like storage sheds, trailers, boats, campers, cabins, and campsites. However, for 28 percent of the fatal incidents (27 percent of deaths), staff could not determine why the generator was in use, or why there was no electricity at the location of the incident.

Most of the generators associated with fatal CO poisoning were gasoline-fueled generators. In 120 of the 616 incidents, staff could not ascertain the fuel type. Of the 496 cases remaining cases, 99 percent (491 of 496) were gasoline-fueled generators. Three additional incidents involved propane-fueled generators (one of which was a welder/generator). Two incidents involved both a gas-fueled generator and a propane-fueled consumer product.

**Table 11: Number of Reported Non-Fire CO Fatalities for Incidents Associated with Generators<sup>1</sup> by Reason for Use, 2012–2022**

Reason for Use		Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	Incidents		43	46	38	52	57	67	57	79	78	69	30
	Deaths	789	49	59	49	77	75	83	76	95	104	85	37
Power outage due to weather, or problem with power distribution	Incidents	103	15	12	5	4	4	16	5	8	15	15	4
	Deaths	139	16	13	5	6	11	21	6	9	26	21	5
Electricity turned off by power company due to bill dispute, nonpayment, or other reason <sup>2</sup>	Incidents	87	5	9	8	11	11	11	6	10	7	7	2
	Deaths	118	6	11	11	22	13	16	8	13	9	7	2
Provide power to temporary locations (storage shed, trailer, boat, camper, cabin, campsite, etc.)	Incidents	114	5	5	5	7	10	11	18	18	19	13	3
	Deaths	139	6	5	7	10	12	12	23	21	25	15	3
New home or homeowner, and power not yet turned on, home under construction or renovation	Incidents	63	3	6	5	5	8	5	6	9	6	5	5
	Deaths	82	4	11	5	8	9	5	8	13	6	7	6
Provide power to home or mobile home that normally does not have electricity	Incidents	56	4	2	5	4	1	10	5	8	9	7	1
	Deaths	72	6	2	8	6	1	14	6	9	12	7	1
Working on or preparing a home for predicted storm/ Periodic testing	Incidents	3	0	0	0	1	1	0	0	0	0	1	0
	Deaths	3	0	0	0	1	1	0	0	0	0	1	0
Provide power to a shed or garage that normally does not have electricity	Incidents	6	1	1	0	0	0	0	3	1	0	0	0
	Deaths	8	1	2	0	0	0	0	4	1	0	0	0
Other (previous fire in house, power shut off by owners, servicing power supply, or other usage)	Incidents	12	1	1	1	4	1	1	1	0	0	1	1
	Deaths	15	1	2	1	4	1	1	2	0	0	1	2
Unknown	Incidents	172	9	10	9	16	21	13	13	25	22	20	14
	Deaths	213	9	13	12	20	27	14	19	29	26	26	18

1 Number of deaths associated with generators includes incidents where other consumer products may also have been involved. Other products include one or more of the following: lawn mowers, portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves.

2 In one incident involving one death in 2021, the power was cut-off due to a hazardous electrical situation in the home. Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

For the 103 fatal incidents associated with a power outage due to weather or a problem with power distribution, Table 12 provides a breakdown by year and a cause of the power outage. Eighty-five percent of the fatal incidents associated with power outages were known to be due to specific weather conditions. Of the 88 incidents (comprising 123 fatalities) when the reason for the outage was known, hurricanes and tropical storms were associated with 41 percent of weather-related CO fatal incidents but 45 percent of the deaths. Ice or snow storms were associated with 35 percent of CO fatal incidents but only 31 percent of the deaths over the 11-year period from 2012 to 2022. Of the 55 known hurricane- or tropical storm-related fatalities between 2012 and 2022, the majority of deaths (67%, 37 deaths) occurred in the 2 years 2017 and 2020, combined.

**Table 12: Number of Reported Non-Fire CO Fatalities for Incidents Associated with Generators<sup>1</sup> by Reason for Power Outage, 2012–2022**

Reason for Power Outage		Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	Incidents	103	15	12	5	4	4	16	5	8	15	15	4
	Deaths	139	16	13	5	6	11	21	6	9	26	21	5
Ice or snow storm <sup>2</sup>	Incidents	31	5	8	1	3	1	0	0	2	2	7	2
	Deaths	38	5	8	1	4	2	0	0	2	2	11	3
Hurricane or tropical storm	Incidents	36	7	0	0	0	1	13	2	1	9	1	2
	Deaths	55	8	0	0	0	1	17	3	1	20	3	2
Wind storm	Incidents	6	1	0	1	1	1	1	0	0	0	1	0
	Deaths	13	1	0	1	2	6	2	0	0	0	1	0
Thunderstorm, rainstorm, or flooding	Incidents	4	0	0	1	0	1	1	0	0	0	1	0
	Deaths	5	0	0	1	0	2	1	0	0	0	1	0
Storm, unspecified	Incidents	11	2	1	1	0	0	0	2	3	0	2	0
	Deaths	12	2	1	1	0	0	0	2	4	0	2	0
Unknown or other reason for outage	Incidents	15	0	3	1	0	0	1	1	2	4	3	0
	Deaths	16	0	4	1	0	0	1	1	2	4	3	0
Total	Incidents	103	15	12	5	4	4	16	5	8	15	15	4
	Deaths	139	16	13	5	6	11	21	6	9	26	21	5

1 Number of deaths associated with generators includes incidents where other consumer products may also have been involved. Other products include one or more of the following: lawn mowers, portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves.

2 This category includes a 2019 incident with flooding during an ice storm. The incident was included here because the victim was attempting to run a gas-powered sump pump to clear water from his house in addition to using a generator.

Note: Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

As shown in Table 8, 553 generator-related, non-fire CO fatalities occurred in a fixed-structure home. The category, “fixed-structure home,” is defined as a permanent, fixed-structure used as a residence, including: houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage. Travel trailers, campers, and RVs are not included in this classification; nor are external structures at the home, such as detached garages or sheds.

Of these 553 generator-related deaths that occurred in a fixed-structure home, information was available for 440 deaths (80%) regarding the victim’s location in relation to the generator. One hundred and seven of these 440 fatalities (24%) occurred in the same room or space as the generator.

The 553 deaths that occurred in a fixed-structure home resulted from 414 incidents (Table 13). These incidents were further classified by the specific location of the generator within the home. The category “Living Space (non-basement)” includes rooms reported as bedrooms, dens, living rooms, landings, home offices, rear rooms, enclosed porches, and converted garages. This category does not include attached garages or basements; nor does it include transitory locations where consumers are not expected to spend a lot of time, such as laundry rooms, utility rooms, or bathrooms. The category “Outside the home” includes incidents in which the generator was placed outside a home, but near an open window, door, or vent of the home. Seventy-three percent (404 of 553) of the CO fatalities at fixed-home locations occurred when a generator was known to be placed inside the home, including the living space (221), a basement/crawlspace (99), in a transitory place (closet/laundry room/utility room/hallway) (25), or inside the house, with no additional information provided (58). Another 18 percent of the fatalities (99 of 553) occurred when the generator was placed in an attached garage, enclosed carport, or attached barn.

Twenty-eight deaths from 17 incidents were associated with the use of a generator placed outside the home. Usually, this involved placing the generator near an open window or vent. This category also includes 2 incidents (accounting for 3 fatalities) in which a generator was running outside the home but inside a building (e.g., outside an apartment but still inside the building). A summary of all fatal scenarios in which a generator was located outside is provided in Appendix C to this report. A 3-person fatality incident in 2021 involved a CO shutoff-equipped generator that was advertised as certified to the voluntary standard *ANSI/PGMA G300-2018, Safety and Performance of Portable Generators*. In this incident, it was reported that the generator was outside of the home, under the eaves that had soffit vents into the attic, with windows and doors locked closed. The exhaust pointed towards one of the closed exterior doors; the generator did not shut off and ran until the gas tank was empty.

**Table 13: Non-Fire CO Poisoning Deaths in the Fixed-Structure Home Location<sup>1</sup> by Location of the Generator,<sup>2</sup> 2012–2022**

Generator Location		Total	2012	2013	2014	2015 <sup>3</sup>	2016	2017	2018	2019	2020	2021	2022
Total	Incidents	414	36	35	28	34	43	49	32	50	43	43	21
	Deaths	553	41	46	36	56	58	64	44	61	63	56	28
Living space (non-basement) <sup>3</sup>	Incidents	157	8	9	12	13	23	22	15	17	14	18	7
	Deaths	221	11	11	18	23	29	29	21	24	21	26	9
Basement/crawlspace	Incidents	76	5	12	9	9	6	8	5	9	4	6	3
	Deaths	99	5	16	11	13	13	10	6	10	5	6	4
Garage/enclosed carport/attached barn	Incidents	76	14	9	2	4	5	7	1	11	8	10	5
	Deaths	99	14	13	2	7	7	10	1	12	16	11	6
Inside house, no further information reported	Incidents	53	5	3	3	3	6	5	3	9	11	4	1
	Deaths	58	5	3	3	4	6	5	5	10	12	4	1
Transit Area (closet/laundry room/utility room/hallway)	Incidents	16	1	1	0	2	1	2	4	0	2	1	2
	Deaths	25	2	1	0	5	1	2	7	0	2	1	4
Outdoors	Incidents	17	1	0	1	1	2	2	2	0	3	3	0
	Deaths	28	2	0	1	2	2	4	2	0	5	7	0
Outside apartment, inside building	Incidents	2	0	1	0	0	0	0	0	0	0	0	1
	Deaths	3	0	2	0	0	0	0	0	0	0	0	1
Unknown location, but at home	Incidents	18	2	0	1	2	0	3	2	4	1	1	2
	Deaths	22	2	0	1	2	0	4	2	5	2	1	3

- 1 This refers to a fixed structure used as a residence, including houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage. Not included here are incidents that occurred in detached structures at home locations (e.g., detached garages, sheds), or at non-fixed location residences (e.g., travel trailers, houseboats).
- 2 Number of deaths associated with generators includes incidents where other consumer products may also have been involved. Other products include one or more of the following: lawn mowers, portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves.
- 3 In 2015, there was one incident (one fatality) where the victim was running two generators simultaneously, one in the living space and one in the basement. This incident was included in the “living space” category because the victim was found in the living space.

Notes: Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.  
Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Table 14 sets forth non-fire CO fatalities that occurred in a fixed-structure home, characterized by ventilation status. Almost half of the incidents with generator-associated fatalities in the home (203 of the 414 incidents, 49%) did not contain information about the ventilation of the generator. Of the other 211 incidents, 134 accounting for 201 deaths,

indicated there was no ventilation when the incident occurred. There were 77 incidents associated with generators in which it was reported that some type of ventilation was attempted. Of these 77 incidents, 49 (62 deaths) were associated with incidents in which it was reported that there was an open or partially open window, door, garage door, or a combination of these. This includes a 2013 incident in which a generator was used to prop open the back door of a store on the first floor of an apartment building. As also noted here, and in Table 13, 15 incidents (26 deaths) were associated with generators that were placed outside the home, near open windows, doors, or vents, where carbon monoxide entered the home. In 13 incidents (15 deaths), consumers actively, but unsuccessfully, attempted to vent generator exhaust outside through a window or door, or by using a fan.

**Table 14: Non-Fire CO Fatalities in the Fixed-Structure Home<sup>1</sup> Reported to CPSC Staff and Associated with Generators<sup>2</sup> Categorized by Status of Ventilation, 2012–2022**

Ventilation Status	Number of Incidents	Number of Deaths	Percentage of Deaths	Percentage of Deaths Where Ventilation is Known
<b>Non-fire CO fatalities in the home</b>	<b>414</b>	<b>553</b>	<b>100%</b>	-
<b>Some ventilation attempted</b>	<b>77</b>	<b>102</b>	<b>18%</b>	<b>34%</b>
Open window(s), open door(s), an open garage door, or a combination of these	49	62	11%	20%
Actively trying to vent either by fans or by directing exhaust out a window or door	13	15	3%	5%
Placed outside of home, but near a window, door, A/C unit, or other outdoor location <sup>3</sup>	15	25	5%	8%
<b>No ventilation</b>	<b>134</b>	<b>201</b>	<b>36%</b>	<b>66%</b>
<b>Unknown ventilation</b>	<b>203</b>	<b>250</b>	<b>45%</b>	-

1 This refers to a fixed-location structure used as a residence, including houses, mobile homes, apartments, and townhouses, as well as structures attached to the house, such as an attached garage. Not included here are incidents that occurred in detached structures at home locations (e.g., detached garages and sheds) or at non-fixed location residences (e.g., travel trailers and houseboats).

2 Number of deaths associated with generators includes incidents where other consumer products may also have been involved. Other products include one or more of the following: lawn mowers, portable LP fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves.

3 One death occurred when a generator was placed outside an apartment in an unvented hallway.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

Table 15 presents a summary of the CO incidents and fatalities characterized by the size of the home in which the fatalities occurred. Home size information was available for 300 of 414 fatal incidents (402 of the 553 deaths). Information regarding the size of the homes reported in this document comes from one of two sources: (1) CPSC IDIs, which include information gathered from police, fire department, or public records; and (2) Internet databases of real estate information, which contain public record data.

Sixty-four percent (192 of 300) of the reported fatal incidents (255 of 402 CO fatalities) associated with generators that occurred in the home, where the size of the structure was known, occurred in homes that were less than 1,500 square feet. Eighty-five percent (254 of 300) of the reported incidents and 86 percent of the deaths (344 of 402) occurred in homes that were less than 2,000 square feet. Table 15 includes incident location details for fatalities that occurred in apartments and mobile homes, as well as fixed structure homes. Fatal incidents that occurred in a detached structure are not included in these figures. The median home size involved in fatal generator-related CO poisoning deaths, where home size information is known, was approximately 1,290 square feet. As a point of reference, according to the U.S. Census Bureau's, *American Housing Survey for the United States: 2021*, the median housing unit as of 2021 was 1,473 square feet. Comparing the percentages of fatal incidents by home size to the U.S. Census figures, it appears that the fatal CO incidents are skewed toward smaller homes. Whether this is due to economic reasons, or because smaller-volume structures are filled more quickly by deadly carbon monoxide, or a combination of the two factors, or some other reason, is unclear.

**Table 15: Non-Fire CO Fatalities in the Fixed-Structure Home<sup>1</sup> Reported to CPSC Staff and Associated with Generators<sup>2</sup> Categorized by Size of Home, 2012–2022**

Home Size (in sq. feet) <sup>3</sup>	Number of Incidents	Number of Deaths	Percentage of Incidents	Percentage of Incidents Where Home Size is Known	Estimated Percentage of U.S. Occupied Housing Units (2021) <sup>4</sup>
<b>Total</b>	<b>414</b>	<b>553</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
Under 500	4	5	1%	1%	3%
500–999	72	90	17%	24%	21%
1,000–1,499	116	160	28%	39%	26%
1,500–1,999	62	89	15%	21%	20%
2,000–2,499	23	27	6%	8%	13%
2,500–2,999	14	16	3%	5%	7%
3,000 or Larger	9	15	2%	3%	10%
Unknown	114	151	28%	-	-

1 This refers to a fixed-location structure used as a residence, including houses, mobile homes, apartments, and townhouses and structures attached to the house, such as an attached garage. Not included here are incidents that occurred in detached structures at home locations (e.g., detached garages and sheds) or at non-fixed location residences (e.g., travel trailers and houseboats).

2 Number of deaths associated with generators includes incidents where other consumer products may also have been involved. Other products include one or more of the following: lawn mowers, portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves.

3 Home size based on CPSC IDIs or from various Internet real estate databases.

4 The 2021 housing unit figures are the most current year available.

Note: Totals may not add to 100 percent due to rounding.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

U.S. Census Bureau, American Housing Survey for the United States: 2021.

## Conclusions

For the period 2012 through 2022, CPSC has received reports of 872 non-fire CO-poisoning deaths from 699 incidents associated with EDTs. The majority of these deaths involved generators, or a generator and another consumer product. OEDTs, including garden tractors, lawn mowers, power washers or sprayers, and others, were associated with a much smaller number of deaths.

The majority of fatal incidents reported to CPSC staff involved a single fatality. Generators accounted for all incidents involving more than one victim; each OEDT incident involved one fatality. Most victims in the generator incidents were above the age of 24, and the majority of the victims were male. Generator incidents also accounted for all child fatalities in this report; five percent of generator-related fatalities were under the age of 15. Every victim associated with OEDT non-fire CO poisoning deaths reported to CPSC staff was a male aged 25 and older. Deaths associated with garden tractors and lawn mowers were often associated with an individual repairing or working on the product in an enclosed space. Most reported deaths occurred while an individual was at home.

In the fatal incidents for which detail on CO alarms is available, alarms were seldom found installed—and many of the installed alarms were inoperable at the time of the fatal incident.

Generators were often used as alternative sources of electricity, due to temporary power outages, or as power sources for temporary shelters. Power outages, most commonly weather-related and utility company shut-off, were the most common reasons for generator usage that resulted in a non-fire CO fatality.

Most of the reported deaths associated with generators occurred at fixed-structure home locations. Also, in the majority of the fatal incidents known to have occurred in a home and involving a generator, the generator was placed in the living area, transit area, or basement of the home. Another common scenario occurred when a generator was used inside an attached garage or shed. Generators were often used with little or no ventilation. Visit the CPSC's Carbon Monoxide Information Center— <http://www.cpsc.gov/en/Safety-Education/Safety-Education-Centers/Carbon-Monoxide-Information-Center/>—for the latest information on recalls, safety tips, safety standards, CO alarms, and downloadable injury prevention materials.

## References

Hnatov, Matthew V. *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 2011-2021*. U.S. Consumer Product Safety Commission. June 2022.

<https://www.cpsc.gov/s3fs-public/Fatal-Incidents-Associated-with-Non-Fire-Carbon-Monoxide-Poisoning-from-Engine-Driven-Generators-and-Other-Engine-Driven-Tools-2011-2021.pdf?VersionId=w1it1Z8oqRDGpO9AzW5Bft.gdXC1rCh>.

U.S. Census Bureau, Population Division. *ACS Demographic and Housing Estimates*. 2019: ACS 5-Year Estimates Data Profiles

[DP02: SELECTED SOCIAL ... - Census Bureau Table](#)

U.S. Census Bureau. *American Housing Survey for the United States: 2021*.

[American Housing Survey \(AHS\) - AHS Table Creator \(census.gov\)](#)

U.S. Consumer Product Safety Commission. *Investigation on Racial and Socioeconomic Differences: Race, Ethnicity, and Socioeconomic Data in Consumer Product Safety*. September 2022.

[https://www.cpsc.gov/s3fs-public/InvestigationonRacialandSocioeconomicDifferencesRaceEthnicityandSocioeconomicDatainConsumerProductSafety\\_Final.pdf?VersionId=mWyAnW1pmp8m.T\\_HyLPeqwFrEHn9jG1w](https://www.cpsc.gov/s3fs-public/InvestigationonRacialandSocioeconomicDifferencesRaceEthnicityandSocioeconomicDatainConsumerProductSafety_Final.pdf?VersionId=mWyAnW1pmp8m.T_HyLPeqwFrEHn9jG1w)

U.S. Department of Agriculture. *Rural-Urban Commuting Area Codes*, October 12, 2016.

<https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx>

University of Washington, WWAMI Rural Health Research Center. *Rural-Urban Commuting Area Codes (RUCAs)*

<http://depts.washington.edu/uwruca/>

## Appendix A: Epidemiology Data Retrieval Specifics

CPSC staff queried epidemiology data from the Consumer Product Safety Commission Risk Management System (CPSRMS). Query results were reviewed to include only non-fire CO poisoning fatality incidents related to EDTs and to exclude duplicates and out-of-scope cases, which were cases that were intentional in nature or that occurred during a work-related activity.

For this report, a fatal incident was deemed in scope if none of the following criteria were violated:

- CO was the primary or contributing factor in the fatality.
- The CO was not fire-related.
- The source of the CO was an EDT, or an EDT used in conjunction with another non-fire-related CO generating source.
- The fatal injury was unintentional in nature.
- The EDT involved was a consumer product.
- The incident was not work related.

Date of Queries: 04/17/2023

Incident Dates: 1/1/12-12/31/22

Product Codes: 113, 606, 800-899, 1062, 1400-1464, 3285-3287

## Appendix B: Engine Class of Generators Involved in Fatal CO Incidents

Table B-1 provides a summary of generator incidents and fatalities broken down by engine classification and year of incident.<sup>4</sup> This summary includes generator-welders (3 incidents, 6 deaths). These incidents are footnoted below the table. In the majority of cases (59%), CPSC staff was unable to obtain sufficient information about the engine class of the involved generator. In the incidents where engine classification could be determined, 35 percent involved Class I powered generators, and 59 percent involved single cylinder Class II powered generators. Handheld class generators were known to be involved in nine incidents (twelve fatalities) during this period; while twin cylinder, Class II powered generators were known to be involved in five incidents and nine fatalities.

Additionally, an incident in 2015 involved both a Class I and Class II, single-cylinder generator. This case was included in the "Class II" category in the summary table. In two other cases, one in 2014 and one in 2018, each involving a single fatality, it was reported that two generators were both in use. In neither case was there information available on the generator classification. Additionally, in three other cases in 2018, one involving two fatalities, multiple generators were at the scene but it was unclear whether more than one was in operation at the time of the fatalities. In one case, two Class I powered generators were present and, in another, two Class II powered generators were present. Finally, there was a case in 2017 with three generators present of unknown classification, although it is not known how many were in use at the time of the fatal accident.

---

<sup>4</sup> Staff used engine classifications defined by the U.S. Environmental Protection Agency (EPA) and also the number of cylinders that the engine has. EPA broadly categorizes small SI engines as either non-handheld or handheld and within each of those categories further distinguishes them into different classes, which are based upon engine displacement. Non-handheld engines are divided into Class I and Class II, with Class I engines having displacement above 80 cc up to 225 cc and Class II having displacement at or above 225 cc but maximum power of 19 kilowatts (kW). Handheld engines, which are divided into Classes III, IV, and V, are all at or below 80 cc.

**Table B-1: Engine Class of Generators Involved in Fatal CO Incidents, 2012–2022**

Year	Handheld		Class I		Class II, Single Cylinder		Class II, Twin Cylinder		Unknown		Total	
	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths
<b>Total</b>	<b>9</b>	<b>12</b>	<b>89</b>	<b>130</b>	<b>148</b>	<b>200</b>	<b>5</b>	<b>9</b>	<b>365</b>	<b>438</b>	<b>616</b>	<b>789</b>
2012	2	3	5	7	6	7			30	32	43	49
2013			10	15	16	20			20	24	46	59
2014	1	1	4	8	5	8	1	1	27	31	38 <sup>2</sup>	49 <sup>2</sup>
2015			6	13	14 <sup>1</sup>	18 <sup>1</sup>	1	1	31 <sup>3</sup>	45 <sup>3</sup>	52	77
2016	1	2	11	17	13	19			32	37	57	75
2017			11	15	17 <sup>2</sup>	20 <sup>2</sup>	1	2	38	46	67	83
2018	1	1	10	16	16	23			30	36	57	76
2019			14	19	19	21			46	55	79	95
2020	1	1	9	10	16	23	1 <sup>2</sup>	4 <sup>2</sup>	51	66	78	104
2021	1	1	7	8	17	28	1	1	43	47	69	85
2022	2	3	2	2	9	13			17	19	30	37

- 1 One incident (one fatality) in 2015 involved both a Class I and Class II generator. This case was included in the “Class II” category.
- 2 These counts include three incidents that involved a generator/welder: one incident in 2014 with one fatality, one in 2017 with one fatality, and one in 2020 with four fatalities.
- 3 In 2015, there was an incident involving a stationary generator of unknown engine classification that was located indoors.

Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.  
 Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

When an IDI did not report the generator’s engine displacement, or it was not obtainable from other information in the IDI, staff classified generators with a reported wattage of 3.5 kW and larger as being powered by a Class II engine and those less than 3.5 kW as powered by either a handheld or a class I engine. To distinguish the handheld-powered generators from the Class I-powered generators when there was no information to ascertain the engine displacement, generators with wattage 2 kW and larger, up to 3.5 kW, were considered to have a Class I engine. There was only one generator (from an incident in 2013) with wattage below 2kW in which the engine displacement could not be ascertained. That was a 1,000 watt generator, which staff classified as a handheld generator because staff’s online review of generators nominally, in this size, showed them being powered by handheld engines. To distinguish the single-cylinder Class II engines from the twin-cylinder Class II engines, staff found from looking at the EPA’s exhaust emission certification database at: <https://www.epa.gov/compliance-and-fuel-economy-data/annual-certification-data-vehicles-engines-and-equipment#small-nrsi> that twin-cylinder Class II engines largely have a maximum engine power of nominally 12 or 13 kW and higher. Staff then found, from looking at manufacturers’ generator specifications available online, that generators with engines having power equal to or greater 12 or 13 kW, typically have a rated power of 9kW and higher. Therefore, generators with rated power of 3.5 kW up to 9 kW were considered powered by a single-cylinder Class II engine and those 9 kW and greater were considered powered by a twin-cylinder Class II engine.

## Appendix C: Fatal CO Exposure Incidents Where Generator Was Located Outside the Victim Location

Table C-1 provides a summary of portable generator incidents and fatalities where the generator was placed outdoors. The table presents the data broken down by the specific type of incident location. This table demonstrates that even when a generator is placed outside the victim location, there can still be potentially fatal scenarios. In fact, 6 percent of all generator incidents (34 of 616) and 6 percent of fatalities (49 of 789) occurred when the victim placed the generator outdoors.

Note that the incidents and deaths presented in this table do not directly correspond to those shown for “Outdoors” incidents as shown in Table 13 because the latter table only presents incidents that occurred at fixed-structure homes. This table includes all locations, including vehicles, apartments in business locations, cabins, and trailers.

There were two incidents in 2016 involving one fatality each where the victim was located outside near the generator. In one incident, a generator was in use in a parking lot, but it was unclear exactly where the decedent was – outside near the generator or inside a vehicle near the generator – this case was included in the “Outside (near generator)” category. In the other incident identified as “Outside (near generator)”, the victim was found sitting in a chair outside of a camper next to a running generator.

**Table C-1: Fatal CO Generator Incidents Where the Generator Was Located Outside of the Occupied Space, 2012–2022**

Location of victim(s)	Incidents	Deaths
<b>Total</b>	<b>34</b>	<b>49</b>
House/Mobile Home	13	22
Apartment	1	2
Cabin	1	1
Vehicle: RV	2	3
Vehicle: Automobile/Truck	2	2
Camper Trailer	10	13
Boat	1	2
Other enclosed space <sup>1</sup>	2	2
Outside (near generator)	2	2

<sup>1</sup> This category includes one incident involving a tent and one involving a cargo container. Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

In September 2021, a 54-year-old woman and her two children (a 23-year-old female and a 17-year-old male) died of CO poisoning while using a CO shutoff-equipped generator that was advertised as certified to the voluntary standard *ANSI/PGMA G300-2018, Safety and Performance of Portable Generators*. It was reported that the generator was outside of their home, under the eaves that had soffit vents into the

attic, with windows and doors locked closed. The exhaust was pointed towards one of the closed exterior doors; the generator did not shut off and ran until the gas tank was empty.

## Appendix D: Carboxyhemoglobin Levels Present in CO Fatalities

Carboxyhemoglobin (COHb) is a complex of carbon monoxide and hemoglobin that forms in red blood cells when carbon monoxide is inhaled. COHb poisoning can be fatal in large doses because it hinders delivery of oxygen to the body. COHb data are helpful in estimating the concentration of CO in the product exhaust and the lethality of the product, which can affect the speed of onset of harm. This information may be used by CPSC staff to assist in determining the best way to address the CO hazard presented by generators and other EDTs.

In healthy adults, a COHb level of 40 to 50 percent in the blood approximately correlates with symptoms of confusion, unconsciousness, coma, and possible death; a level of 50 to 70 percent approximately correlates with symptoms of coma, brain damage, seizure, and death; and a level greater than 70 percent is typically fatal.<sup>5</sup> COHb levels were available for 461 of the 872 fatalities (53% of the CO fatalities). Table D-1 shows the frequency of reports by COHb level categories. Percentages in the table are the category proportions of reported COHb levels. Eighty-four percent (387 of the 461) of fatalities had reported COHb levels of 50 percent or greater.

**Table D-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire CO Poisoning Deaths, 2012–2022<sup>1</sup>**

COHb Level	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
<b>Total</b>	<b>872</b>	<b>-</b>	<b>789</b>	<b>-</b>	<b>83</b>	<b>-</b>
<b>Reported Levels</b>	<b>461</b>	<b>100%</b>	<b>419</b>	<b>100%</b>	<b>42</b>	<b>100%</b>
Less than 30%	21	5%	21	5%	0	0%
30–39.9%	14	3%	12	3%	2	5%
40–49.9%	39	8%	38	9%	1	2%
50–59.9%	70	15%	65	16%	5	12%
60–69.9%	155	34%	141	34%	14	33%
70–79.9%	122	26%	105	25%	17	40%
80–89.9%	35	8%	32	8%	3	7%
90–99.9%	5	1%	5	1%	0	0%
<b>Not reported<sup>2</sup></b>	<b>411</b>	<b>-</b>	<b>370</b>	<b>-</b>	<b>41</b>	<b>-</b>

<sup>5</sup> Inkster S.E. *Health hazard assessment of CO poisoning associated with emissions from a portable, 5.5 Kilowatt, gasoline-powered generator*. Washington, D.C.: U.S. Consumer Product Safety Commission. 2004.

1 Percentages shown are the percentage of reported COHb levels per category.

2 One victim is included in the "Not reported" category because the report simply stated that the measurement was beyond the instrument's calibration but did not provide any number.

Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.

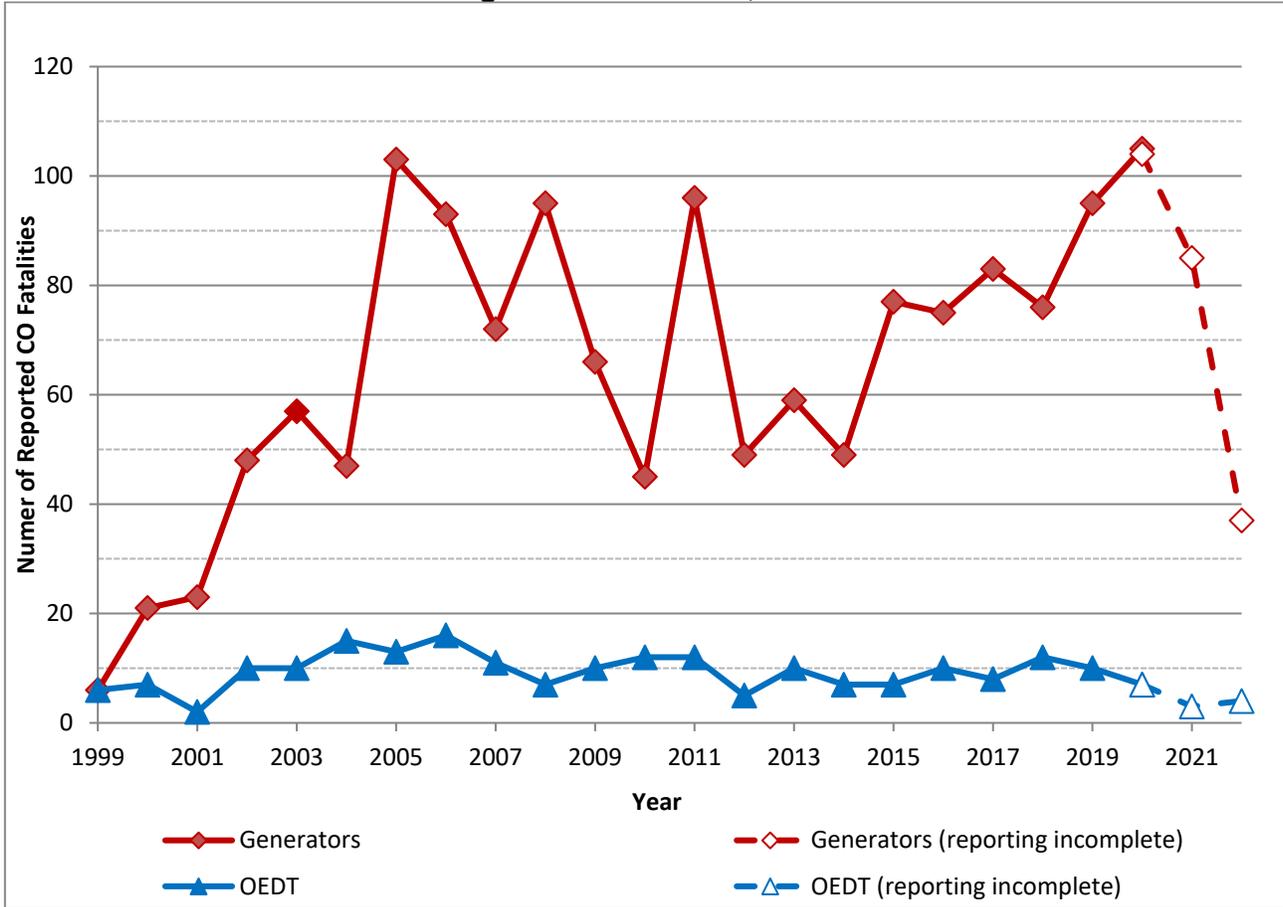
## Appendix E: Historical Data

Figure 1 illustrates the trend in the number of non-fire CO fatalities associated with the use of generators and other EDTs from 1999 to 2022. The number of generator-related fatalities increased at a steady rate from six in 1999 to 103 in 2005. From 2006 through 2014, the number of yearly fatalities oscillated between less than 45 and nearly 100 fatalities per year. But it appears that the annual number of CO fatalities attributed to generators has been increasing from 2014 through 2020. The 2020 fatalities count surpasses the previous high count from the significant hurricane year of 2005. While generator-related deaths have increased, the number of CO fatalities associated with the use of OEDTs has been relatively steady over the period 1999 through 2022.

Due to reporting delays, fatality counts ultimately reported in future annual reports for the most recent years are likely to increase substantially. Since the 2011 annual report, the most recent year's counts have increased by an average of about 51 percent from the previous year's report, when additional information became available. Between the second and third year, the average increase, report to report, is about six percent. In recent years, reporting delays have been even greater.

It also should be noted that the incomplete rates have been increasing over the last few years. Since 2020, most recent year's counts have increased by an average of about 81 percent from the previous report. Between the second and third year, the average increase over the past three years, report to report, is about six percent. This may be due to delays in reporting associated with the COVID-19 Pandemic.

**Figure 1: Number of Reported Non-Fire CO Fatalities Associated with Engine-Driven Tools, 1999–2022**



1 This chart includes incidents involving stationary generators: three in 2011 accounting for 5 deaths, and one in 2015 accounting for 1 death.

Note: Data presented in this graph are based on anecdotal data; no statistical inference about the trend is possible.  
 Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2023.