



# **Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2012**

Matthew V. Hnatov  
U.S. Consumer Product Safety Commission  
Directorate for Epidemiology  
Division of Hazard Analysis  
4330 East West Highway  
Bethesda, MD 20814  
August 2013

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

## Table of Contents

Introduction .....	7
<b>I. Reported Numbers of Fatalities by Engine-Driven Tool (EDT) Product Type .....</b>	<b>9</b>
<b>Table 1: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools, 1999–2012 .....</b>	<b>10</b>
<b>Table 2: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools by Number of Deaths per Incident, 1999–2012.....</b>	<b>11</b>
<b>Table 3: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools by Year, 1999–2012.....</b>	<b>12</b>
<b>Figure 1: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools, 1999–2012 .....</b>	<b>13</b>
<b>II. Socio-Demographic Characteristics of Victims and EDT Use Patterns .....</b>	<b>14</b>
<b>Table 4: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Age of Victim, 1999–2012 .....</b>	<b>14</b>
<b>Table 5: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Gender of Victim, 1999–2012.....</b>	<b>15</b>
<b>Table 6: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Race/Ethnicity of Victim, 1999–2012.....</b>	<b>16</b>
<b>Table 7: Number of Reported Non-Fire Carbon Monoxide Incidents and Fatalities Associated with Engine-Driven Tools by Season, 1999–2012.....</b>	<b>17</b>
<b>Table 8: Number of Reported Non-Fire Carbon Monoxide Incidents and Fatalities Associated with Engine-Driven Tools by Location, 1999–2012 .....</b>	<b>19</b>
<b>Table 9: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Population Density of Place of Death, 1999–2012 .....</b>	<b>21</b>
<b>III. Alarm Usage.....</b>	<b>22</b>
<b>Table 10: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999–2012.....</b>	<b>23</b>
<b>IV. Hazard Patterns Associated with Generators.....</b>	<b>24</b>
<b>Table 11: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators by Reason for Use, 1999–2012 .....</b>	<b>25</b>
<b>Table 12: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators by Reason for Power Outage, 1999–2012 .....</b>	<b>26</b>
<b>Table 13: Non-Fire Carbon Monoxide Poisoning Deaths in the Fixed-structure Home Location by Location of the Generator,<sup>2</sup> 1999–2012 .....</b>	<b>28</b>
<b>Table 14: Non-Fire CO Fatalities in the Fixed-structure Home Reported to CPSC Staff and Associated with Generators<sup>2</sup> Categorized by Status of Ventilation, 1999–2012 .....</b>	<b>29</b>

<b>Table 15: Non-Fire CO Fatalities in the Fixed-structure Home Reported to CPSC Staff and Associated with Generators Categorized by Size of Home, 1999–2012.....</b>	<b>31</b>
<b>Table 16: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators Categorized by Generator Wattage Rating, 1999–2012.....</b>	<b>32</b>
<b>Conclusion.....</b>	<b>33</b>
<b>References .....</b>	<b>34</b>
<b>Appendix A: Epidemiology Data Retrieval Specifics.....</b>	<b>35</b>
<b>Appendix B: Carboxyhemoglobin Levels Present In CO Fatalities .....</b>	<b>36</b>
<b>Table B-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999–2012.....</b>	<b>37</b>

## Executive Summary

This report summarizes non-fire carbon monoxide (CO) incidents associated with engine-driven generators and other engine-driven tools that occurred between 1999 and 2012, and were reported to U.S. Consumer Product Safety Commission (CPSC) staff as of April 23, 2013. It should be noted that due to incident reporting delays, statistics for the most recent years should be considered incomplete. In this report, the two most recent years, 2011 and 2012, are identified as being incomplete because these figures most likely will change in future reports. Throughout this report, the number of deaths represents a count of the fatalities reported to CPSC staff associated with generators and other engine-driven tools, such as power lawn mowers, garden tractors, portable pumps, power sprayers and washers, snow blowers, and concrete saws. Also included in this report are summaries of fatal, non-fire CO incidents, where an engine-driven tool (EDT) and 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. These fatalities are characterized in the “Multiple Product” category. This report also provides a more detailed summary of fatal, non-fire CO poisoning incidents associated with engine-driven tools, with particular emphasis on cases involving generator use, based on information found in the CPSC’s In-Depth Investigation (INDP) File.

Some of the findings of this report are provided below:

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

- The total number of fatalities for 1999 through 2012 increased by 50 from the 881 fatalities summarized in the July 2012 report, which reported fatalities for the period 1999 through 2011, as of April 20, 2012.
- From 1999 through 2012, 931 fatalities from 725 incidents were associated with the use of engine-driven tools, or engine-driven tools used in conjunction with another potentially CO-emitting consumer product.
- As of April 23, 2013, there were 37 reported non-fire CO fatalities in 2012, from a total of 32 incidents. Thirty-three of these deaths (28 incidents) involved only a generator and no other product; three deaths (three incidents) were associated with a non-generator other engine-driven tool (OEDT); and one death (one incident) was associated with multiple fuel-burning consumer products, one of which was a generator.
- From 1999 to 2012, of the 931 fatalities from 725 incidents, 739 (79%) (552 incidents) were associated with generators; 126 fatalities (14%) from 123 incidents involved other engine-driven tools; and 66 fatalities (7%) from 50 incidents involved multiple fuel-burning consumer products where one product was either a generator (60 of 66 deaths) or an OEDT (five of 66 deaths) and the other product was a non-EDT, or where one product was a generator and one was an OEDT (1 of 60 deaths).
- Of the 50 incidents that involved multiple consumer products, all but two incidents involved a heating or cooking product, most commonly a portable LP- or kerosene-fueled portable

---

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

heater. One incident involved a generator and an OEDT (a lawnmower), and another incident involved two gasoline-fueled OEDTs (a lawnmower and trimmer).

- Twenty-five percent of generator-related, non-fire CO incidents caused multiple fatalities, while only three of the OEDT-related incidents (2%) involved multiple fatalities. Twenty-six percent of multiple product-related, non-fire CO incidents caused multiple fatalities.
- Nearly three-fourths (598 of 800) of generator-related fatalities detailed in this report (including fatalities involving multiple products where one product was a generator) occurred between 2005 and 2012. Seventy-two percent of all engine-driven, tool-related CO poisoning deaths reported to CPSC since 1999 occurred in the most recent eight years.

### **Socio-Demographic Characteristics of Victims and EDT-Use Patterns:**

- Eighty-three percent of generator-related victims (including multiple product incidents where a generator was involved) were known to be 25 years old or older. By contrast, 99 percent of OEDT-related victims (all but one) were 25 years old or older.
- Nearly three-quarters of the generator-related, non-fire CO victims were male, while 97 percent (all but four) of the OEDT-related fatalities were male.
- Twenty-three percent of generator-related, non-fire CO fatalities were non-Hispanic Black or African American, nearly double the non-Hispanic Black or African American proportion of the U.S. population. Eighty-nine percent of other engine-driven tool-related, non-fire CO fatalities were non-Hispanic White, much higher than the non-Hispanic White proportion (67%) of the U.S. population.
- Half of generator-related, non-fire CO fatalities (402 of 800, including multiple product incidents) occurred in the four cold months of the year (November through February), while CO fatalities associated with OEDTs were only slightly more prevalent in the cold months (40%) than in the transitional and warm months (33% and 27%, respectively).
- Seventy-four percent of the generator-related fatalities (including incidents involving multiple products, where one was a generator) occurred in fixed-structure homes, while 60 percent of OEDT fatalities occurred in fixed-structure homes.
- Fifty-six percent of the EDT-related fatalities are known to have occurred in urban areas. Seventeen percent occurred in small rural and isolated areas, nearly double the proportion of the U.S. population that lives in such areas.

### **CO Alarm Usage:**

- A CO alarm was reported to have been present in only 21 of 279 incidents where alarm presence was known, which accounted for 30 of 385 (8%) EDT-related CO fatalities. In eleven of the incidents (18 deaths), the alarm was inoperable due to no batteries, batteries inserted incorrectly, probable drained batteries, or no electric current. The alarm sounded in six incidents (six deaths), but the signal was either misunderstood or the alarm sounded inside the house while the fatality occurred inside an attached garage (presumably, the death occurred in the garage before CO levels increased inside the house sufficient to set off the CO alarm). Additionally, there were four incidents (six deaths) in which the presence of a CO alarm was noted, but it is unknown if the alarm sounded during the event.

### **Hazard Patterns Associated with Generators:**

- Thirty percent of all generator-related, non-fire CO deaths (236 of 800) from 1999 through 2012 were associated with power outages, mostly due to weather-related issues. The two most common causes of fatal incidents due to weather-related outages were ice/snow storms (77 incidents, 107 deaths) and hurricanes/tropical storms (49 incidents, 71 deaths). The second most common reason for generator usage in the reported CO fatalities was due to power shut-off, accounting for 19 percent (153 deaths) of the all reported fatalities.
- Five hundred eighty-eight non-fire CO fatalities (439 incidents) that occurred in fixed-structure homes were associated with a generator or a generator in use with another CO-generating consumer product. Sixty-nine percent (407 deaths, 295 incidents) occurred when the generator was placed inside the living area of the home, including the basement, closets, and doorways, but excluding the attached garage, enclosed carport, or attached barn.
- In recent years, the most common location of generators associated with CO fatalities has shifted from the basement to the non-basement living space of the home. From 2004 through 2012, 36 percent of fatal CO incidents (38% of deaths) in the home occurred with a generator placed in the non-basement living space of the home. From 1999 through 2003, 26 percent of fatal incidents (21% of deaths) occurred in non-basement living space scenarios.
- More than two-thirds of generator-related, non-fire fatal CO incidents in fixed-structure homes (for which information on ventilation of the generator was available) occurred when no ventilation of the generator was attempted.
- Fifty-nine percent of the generator-related, non-fire fatal CO incidents (61% of deaths) in fixed-structure homes, where the size of the home was known and the generator was not located in an external structure, occurred in houses less than 1,500 square feet in size; 85 percent (85% of deaths) occurred in houses less than 2,000 square feet in size.
- Nearly two-thirds (174 of 266) of fatal CO incidents, where the size of the generator was known, were associated with generators in the 3500 to 6499 watt range, and nearly half (46%; 122 of 266) were associated with generators in the 5000 to 6499 watt range.

#### **Carboxyhemoglobin Levels in CO Fatality Victims:**

- Of the CO fatality victims associated with engine-driven tools, 81 percent 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 2011 and 2012 are italicized in table headings, indicating that incident and death counts may change as additional information is received. Incident and death counts may change for other years but to a much smaller extent.*

---

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

## Introduction

The following U.S. Consumer Product Safety Commission (CPSC) databases were searched to prepare the statistics recorded in this report: the In-Depth Investigation (INDP) File, the Injury or Potential Injury Incident (IPII) File, and the Death Certificate (DTHS) File. 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 records possible in a single database. At this stage, each record was reviewed to determine whether the incident was in scope for this report and to correct any discrepancies between 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 those incidents reported and entered into CPSC databases on or before April 23, 2013. 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 were included.

CPSC records contain information on 931 non-fire CO fatalities associated with EDTs during the years 1999 through 2012. Since the last report in 2012, there have been 55 new CO fatalities reported to CPSC. Additionally, five reported fatalities have been removed from the report summaries (see below for details). This is a net increase of 50 fatalities from the 881 fatalities reported in the July 2012 report on non-fire CO fatalities associated with EDTs, which included data entered into CPSC databases as of April 20, 2012.<sup>3</sup>

Changes to previous report:

- 2006 – one two-fatality incident was removed. An incident involving two deaths was found to have been double counted due to differences in reported incident date. Further information retrieved from an Internet search revealed information linking these two incidents.
- 2007 – one new one-fatality incident added.
- 2008 – one new one-fatality incident added.
- 2009 – one one-fatality incident removed. A fatal incident was found to have been double counted due to differences in reported incident date. Additional information retrieved from an Internet search revealed information linking incidents.
- 2010 – Two new one-fatality incidents added.
- 2011 – Thirteen new incidents added, accounting for 14 deaths. Two one-fatality incidents removed—new information revealed that two CO poisonings were due to products not under CPSC jurisdiction.
- 2012 – Thirty-two new incidents added, accounting for 37 deaths.

Thirty-six of the 37 fatalities reported to CPSC that occurred in 2012, were associated with generators or other engine-driven tools (OEDT) as the only known sources of the CO. One additional fatality was associated with the use of a generator and a portable LP heater. Incidents associated with generators that were specifically reported as integral parts of recreational vehicles

---

<sup>3</sup> Hnatov, M. V. *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2011*. U.S. Consumer Product Safety Commission. July 2012.

(RVs), motor homes, or boats are not within the jurisdiction of the CPSC; and thus, these incidents were considered out of scope and were not included. For example, generators that were reportedly mounted to an RV 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 determined to be other than unintentional in nature was considered to be out of scope, as were work-related incidents, which are 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 helpful in 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 generator usage patterns that may lead to fatal CO poisoning events.

Additionally, Appendix B presents summary findings on carboxyhemoglobin 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.

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

As of April 23, 2013, CPSC staff had records indicating that there were 32 fatal, non-fire carbon monoxide (CO) exposure incidents involving engine-driven tools between January 1, 2012 and December 31, 2012. Thirty-seven deaths occurred in these 32 fatal CO incidents. Table 1 presents the reported fatal incidents and the number of deaths in 2012, along with a summary of CO incidents and fatalities associated with engine-driven tools for the 14-year period from 1999 through 2012. The table records the number of incidents and deaths by the broad categories of “Generators,” “Other Engine-Driven Tools,” and “Multiple Products.” Multiple product incidents are fatal CO poisonings that involved multiple fuel-burning consumer products that generate CO, at least one being an EDT, or in which investigating authorities could not determine which of multiple consumer products in use at the time of the incident was the source of the CO. CPSC staff is aware of 66 fatalities associated with multiple consumer products, occurring between 1999 and 2012; one of these fatalities occurred in 2012. Multiple product incidents, where one of the sources of CO is not under the CPSC’s jurisdiction, such as automobiles, boats, or recreational vehicles, were determined to be out of scope and are not included in this report.

Within each broad category, the frequency of reports is summarized by product type. Staff is aware of 725 incidents with a total of 931 deaths due to non-fire CO exposure that occurred between 1999 and 2012, involving engine-driven tools.

In Table 1, the product type “welder” appears in both the “Generator” and “Other Engine-Driven Tool” categories. Some welding equipment is designed to be used as a welder or as an electric generator. Two of the fatal, non-fire CO incidents associated with the use of welding equipment that occurred between 1999 and 2012, involved the use of the welder as a generator during a power outage. Each of these two incidents involved a single death. There were six fatal, non-fire CO incidents between 1999 and 2012, which were associated with the use of welder equipment, where it was not specifically identified as being used as a generator. Of these six incidents, one incident (involving two deaths) occurred when the welder was being used as a source of heat, and, in the other five incidents (six deaths: four single-fatality incidents and one two-fatality incident), the welder was being used for welding purposes or the method of usage could not be ascertained. These latter five incidents were included in the “Other Engine-Driven Tools” category because there was no evidence indicating that the welders were being used as generators.

All but two of the 66 non-fire, CO fatalities in the “Multiple Products” category for 1999–2012 involved a heating- or cooking-related consumer product other than an EDT. One incident involved a generator and a lawn tractor being run in a closed garage. The other incident involved a gasoline-fueled, walk-behind mower and a gasoline-fueled trimmer, also running in a closed garage.

**Table 1: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools, 1999–2012**

Product	2011		2012		Total: 1999–2012	
	Number of Incidents	Number of Deaths	Number of Incidents	Number of Deaths	Number of Incidents	Number of Deaths
<b>Total Engine-Driven Tools</b>	<b>73</b>	<b>100</b>	<b>32</b>	<b>37</b>	<b>725</b>	<b>931</b>
<b>Generators</b>	<b>59</b>	<b>84</b>	<b>28</b>	<b>33</b>	<b>552</b>	<b>739</b>
Generator, portable	56	79	28	33	547	732
Generator, fixed	3	5	0	0	3	5
Welder (used as a generator) <sup>1</sup>	0	0	0	0	2	2
<b>Other Engine-Driven Tools (OEDT)</b>	<b>9</b>	<b>9</b>	<b>3</b>	<b>3</b>	<b>123</b>	<b>126</b>
Lawn mowers	5	5	2	2	73	73
Riding lawn mower/Garden tractor	5	5	2	2	65	65
Push lawn mower	0	0	0	0	3	3
Powered lawn mower, unspecified type	0	0	0	0	5	5
Power washer/sprayer	2	2	0	0	10	10
Snow blower	1	1	0	0	11	11
All-terrain vehicle	0	0	1	1	8	9
Welder (used as welder or other reason) <sup>1</sup>	0	0	0	0	6	8
Water pump	0	0	0	0	4	4
Concrete saw	0	0	0	0	3	3
Air compressor	0	0	0	0	2	2
Paint sprayer	0	0	0	0	1	1
Snowmobile	0	0	0	0	1	1
Go-cart	0	0	0	0	1	1
Tiller	0	0	0	0	1	1
Small engine (unknown use)	0	0	0	0	1	1
Edger	1	1	0	0	1	1
<b>Multiple Products<sup>2</sup></b>	<b>5</b>	<b>7</b>	<b>1</b>	<b>1</b>	<b>50</b>	<b>66</b>
Generator + Other Consumer Product <sup>3</sup>	5	7	1	1	45	61
OEDT + Other Consumer Product <sup>4</sup>	0	0	0	0	5	5

1 Some welding equipment is designed to be used as either a welder or a generator.

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, and one case with a generator and an OEDT (lawn tractor) in operation.

3 This category includes one incident involving one fatality where a generator and an OEDT were being used concurrently.

4 The incidents associated with an OEDT and another consumer product include the following engine-driven tools: two incidents involving lawn mowers, one incident involving a log splitter, one involving a snow blower, and one involving a tiller.

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, 2013.

Five hundred and fifty-two of the 725 incidents reported to CPSC staff during the 1999-2012 period were associated with a generator and accounted for 739 of the 931 CO deaths (79%). Additionally, 61 other CO fatalities from 45 incidents were associated with the use of a generator and another combustion consumer product—most commonly an LP- or kerosene-fueled heater. One of these fatalities involved a generator and another engine-driven tool (lawn tractor). For the rest of this report, this incident will be included in the tables and discussions in the category, *Multiple Products*, involving a generator. Throughout the remainder of this report, incidents associated with

all non-generator engine-driven tools are reported as a group. In addition, because the majority of incidents were associated with generators, characteristics of these incidents are reported separately in Section IV. More than half of the non-fire, non-generator CO fatalities (75 of 131, 57%) involved a garden tractor or other powered lawn mower (including multiple product incidents). Deaths associated with powered lawn mowers were often associated with an individual repairing or working on the product in an enclosed space.

CPSC staff examined the number of deaths associated with each fatal incident (Table 2). Of the 725 fatal incidents, 79 percent involved a single fatality. Seventy-five percent (413 of 552) of the fatal generator-related incidents involved a single fatality. One incident involving a generator resulted in the deaths of six individuals, and two others involved five fatalities. Of the 123 fatal incidents in the “Other Engine-Driven Tools” category, three incidents resulted in more than one fatality. Twenty-six percent of multiple-product, fatal CO incidents resulted in multiple fatalities.

**Table 2: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools by Number of Deaths per Incident, 1999–2012**

Number of Deaths Reported in Incident <sup>1</sup>	All Engine-Driven Tools (EDTs)		Generator		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>2,3</sup>	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
<b>All Incidents</b>	<b>725</b>	<b>100%</b>	<b>552</b>	<b>100%</b>	<b>123</b>	<b>100%</b>	<b>50 (45)</b>	<b>100%</b>
1	570	79%	413	75%	120	98%	37 (32)	74%
2	118	16%	105	19%	3	2%	10 (10)	20%
3	26	4%	23	4%	0	0%	3 (3)	6%
4	8	1%	8	1%	0	0%	0 (0)	0%
5	2	< 1%	2	< 1%	0	0%	0 (0)	0%
6	1	< 1%	1	< 1%	0	0%	0 (0)	0%

- 1 SPECIAL NOTE ABOUT COUNTS IN THIS TABLE ONLY: One incident included in this table involved an in-scope, generator-related death and an out-of-scope death (work related). Because two fatalities were involved in the incident, this incident is included as a two-fatality incident. The out-of-scope fatality is not included elsewhere in the report. Therefore, in this table only, there is one additional fatality reported. The in-scope fatality was a generator-related fatality, so it is included in the “Generator” and “Total” columns.
- 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, and one case with a generator and another engine-driven tool (lawn tractor) in operation.
- 3 Numbers in parentheses indicate incidents involving a generator and another product, including a case where a generator and an OEDT (lawn mower) were used concurrently.

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

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, 2013.

CPSC staff summarized the number of reported deaths associated with engine-driven tools 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 23, 2013. 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. Thirty-three percent (18 of 55) of the reported fatalities new to the report were for years prior to 2012. For the 14 years covered by this report, 72 percent

(679 of 931) of the deaths were reported as having occurred in the most recent eight years (2005 through 2012).

The average number of non-fire CO fatalities associated with both generators and other engine-driven tools for years 2008 through 2010 is also presented in Table 3. These three years represent the most recent years for which CPSC staff believe reporting is substantially complete. Due to reporting delays, these averages may change slightly in the future when data are complete. Figure 1 illustrates the trend in engine-driven, tool-related, non-fire CO fatalities since 1999.

**Table 3: Number of Reported Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Associated with Engine-Driven Tools by Year, 1999–2012**

Year	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths
<i>Total</i>	<i>725</i>	<i>931</i>	<i>552</i>	<i>739</i>	<i>123</i>	<i>126</i>	<i>50 (45)</i>	<i>66 (61)</i>
1999	12	12	6	6	5	5	1 (0)	1 (0)
2000	22	28	14	20	7	7	1 (1)	1 (1)
2001	19	25	14	17	2	2	3 (3)	6 (6)
2002	47	58	34	42	8	9	5 (4)	7 (6)
2003	51	67	38	52	9	9	4 (3)	6 (5)
2004	50	62	34	46	14	14	2 (1)	2 (1)
2005	93	116	73	94	13	13	7 (7)	9 (9)
2006	79	109	59	87	16	16	4 (4)	6 (6)
2007	69	82	54	66	11	11	4 (4)	5 (5)
2008	77	102	64	88	6	6	7 (6)	8 (7)
2009	55	76	43	64	10	10	2 (2)	2 (2)
2010	46	57	32	40	10	12	4 (4)	5 (5)
2011	73	100	59	84	9	9	5 (5)	7 (7)
2012	32	37	28	33	3	3	1 (1)	1 (1)
Average: 2008–2010	59	78	46	64	9	9	4 (4)	5 (5)

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating 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, and one case with a generator and another engine-driven tool (lawn tractor) in operation.

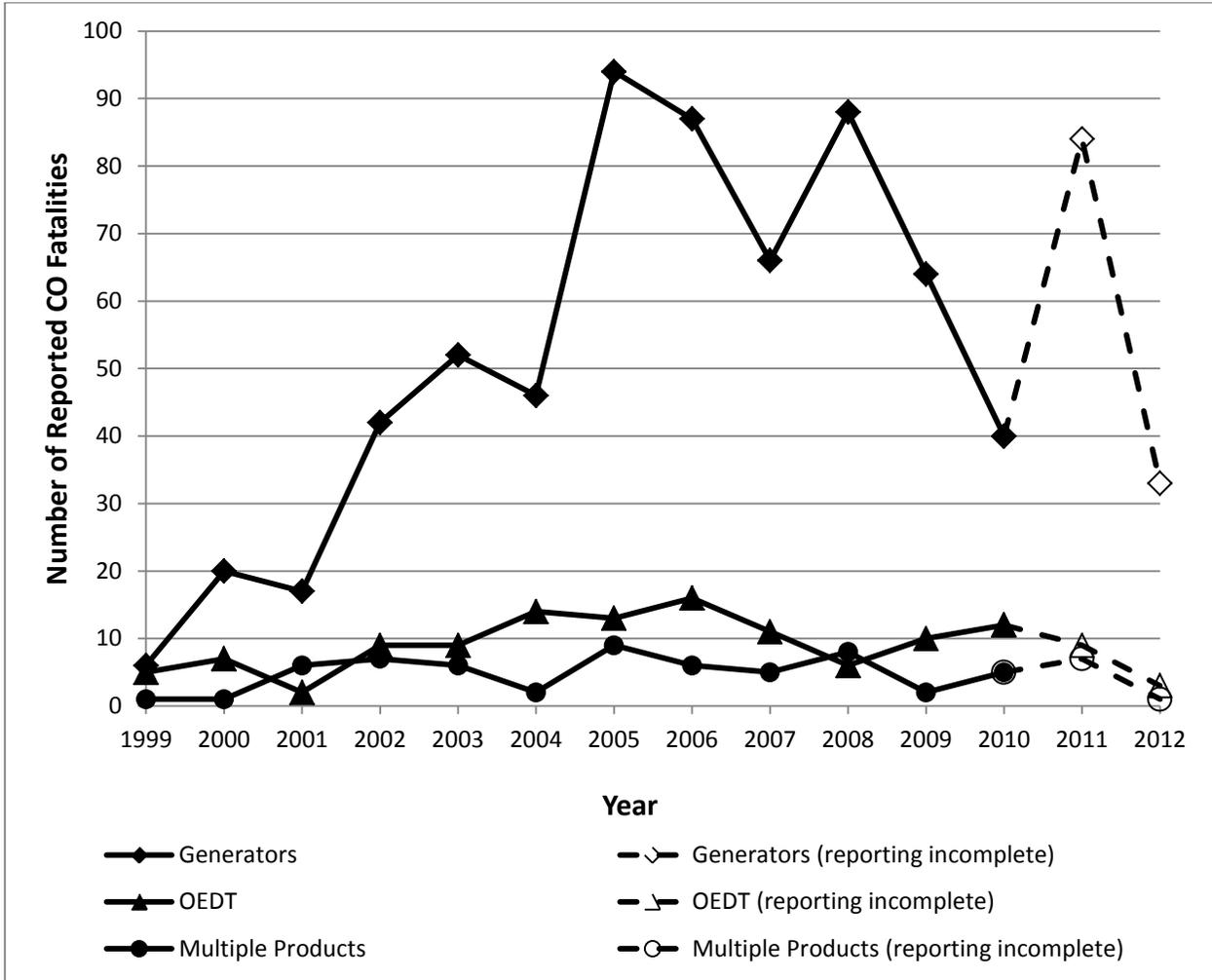
2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn tractor) were used concurrently.

Notes: Detail averages may not sum to total average due to rounding.

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, 2013.

**Figure 1: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools, 1999–2012**



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

This section presents socio-demographic information about the victims of reported fatal CO incidents associated with engine-driven tools (EDTs). Tables 4, 5, and 6 present summaries of socio-demographic characteristics of the victims. Table 4 presents the distribution of ages of the victims. Victims age 25 years or older accounted for about 86 percent (791 of 925) of reported non-fire, CO poisoning deaths associated with all engine-driven tools, where the victim's age is known. Victims with a reported age of 25 years or older accounted for about 83 percent (661 of the 794 victims where the age was known) of non-fire CO poisoning deaths associated with generators (including multiple product related deaths where one product was a generator) and accounted for nearly all of the deaths associated with other engine-driven tools. Eighty-four percent of the non-fire CO fatalities associated with non-generator, engine-driven tools (110 of 131) involved victims age 45 or older, with only one reported fatality of an individual younger than 25.

**Table 4: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Age of Victim, 1999–2012**

Age	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>Total</b>	<b>931</b>	<b>100%</b>	<b>739</b>	<b>100%</b>	<b>126</b>	<b>100%</b>	<b>66 (61)</b>	<b>100%</b>
Under 5	15	2%	15	2%	0	0%	0 (0)	0%
5–14	31	3%	31	4%	0	0%	0 (0)	0%
15–24	88	9%	79	11%	1	1%	8 (8)	12%
25–44	276	30%	239	32%	20	16%	17 (17)	26%
45–64	348	37%	253	34%	63	50%	32 (29)	48%
65 and over	167	18%	116	16%	42	33%	9 (7)	14%
Adult, age unknown	6	1%	6	1%	0	0%	0 (0)	0%

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating 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, and one case with a generator and another engine-driven tool (lawn mower) in operation.

2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were used concurrently.

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

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, 2013.

Table 5 presents the distribution of the gender of the victims. Male victims accounted for 77 percent of the deaths associated with all engine-driven tools when the gender of the victim is known. Male victims comprised 73 percent of the deaths associated with generators and 97 percent of non-generator, engine-driven tool fatalities.

**Table 5: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Gender of Victim, 1999–2012**

Gender	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>Total</b>	<b>931</b>	<b>100%</b>	<b>739</b>	<b>100%</b>	<b>126</b>	<b>100%</b>	<b>66 (61)</b>	<b>100%</b>
Male	720	77%	542	73%	122	97%	56 (51)	85%
Female	209	22%	195	26%	4	3%	10 (10)	15%
Unknown	2	< 1%	2	< 1%	0	0%	0 (0)	0%

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating 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, and one case with a generator and another engine-driven tool (lawn mower) in operation.

2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were used concurrently.

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

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, 2013.

Table 6 presents a summary of the race/ethnicity of the reported CO fatalities associated with engine-driven tools. The percentage of generator-related CO fatalities identified as “Black/African American” (23% of deaths) was nearly double the proportion classified by the U.S. Census Bureau as “Black/African Americans” in the U.S. population (an estimated 12%). The percentage of the non-generator, engine drive tools-related CO fatalities identified as “White” (89% of deaths) was much higher than proportion classified as “White” by of the U.S. Census Bureau (an estimated 67% of the U.S. population).

**Table 6: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Race/Ethnicity of Victim, 1999–2012**

Race / Ethnicity	Percentage of Average Estimated U.S. Resident Population <sup>3</sup>	Number of Deaths Reported to CPSC							
		All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
		Deaths	Percentage	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
<b>Total</b>		<b>931</b>	<b>100%</b>	<b>739</b>	<b>100%</b>	<b>126</b>	<b>100%</b>	<b>66 (61)</b>	<b>100%</b>
White	67%	591	63%	433	59%	112	89%	46 (41)	70%
Black/African American	12%	185	20%	171	23%	3	2%	11 (11)	17%
Hispanic (any race)	14%	93	10%	88	12%	1	1%	4 (4)	6%
Asian	4%	15	2%	13	2%	1	1%	1 (1)	2%
Native American	1%	9	1%	9	1%	0	0%	0 (0)	0%
Other / Unknown	-	38	4%	25	3%	9	7%	4 (4)	6%

- 1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating 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, and one case with a generator and another engine-driven tool (lawn mower) in operation.
- 2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were used concurrently.
- 3 This percentage represents the average percentage over the 10-year period 2000 through 2009. All categories, with the exception of “Hispanic (any race)” are non-Hispanic averages.

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

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

Sources: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2013.

U. S. Census Department, The 2012 Statistical Abstract - The National Data Book, Table 6.

Staff examined reported deaths associated with engine-driven tools 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 defined as November, December, January, and February; “Warm months” as May, June, July, and August; and “Transitional months” as March, April, September, and October.

Half (48%, or 50% when multiple product incidents where a generator was involved are taken into account) of the non-fire CO deaths associated with generators occurred in the cold months of November through February. Many of the fatalities can be directly associated with the use of generators during power outages due to weather conditions, such as ice or snow storms. Thirty percent of the generator-related CO deaths occurred in the transitional months of March, April, September, and October. 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, due to hurricanes and tropical storms, many of which occurred in September and, to a lesser extent, October. Additional details on this issue are presented in Section IV of this report.

For OEDTs, CO fatalities were only slightly more prevalent in the cold months (40%) than the transitional months (33%) and warm months (27%). The *Multiple Products* category had a very large proportion of fatalities in the cold months (76%), with 21 percent in the transitional months and three percent occurring in the warm months. This large percentage of fatalities in the cold months can be explained by examining the other fuel-burning consumer products in use at the time of the deaths. Of the 66 CO fatalities that involved multiple consumer products, 61 involved the use of a generator, and all but two involved a heating or cooking product, most commonly a portable LP- or kerosene-fueled portable heater. Heaters are used almost exclusively in the cold and transitional months.

**Table 7: Number of Reported Non-Fire Carbon Monoxide Incidents and Fatalities Associated with Engine-Driven Tools by Season, 1999–2012**

Season Incident Occurred		Number of Incidents and Deaths Reported to CPSC							
		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
Total	Incidents	725	100%	552	100%	123	100%	50 (45)	100%
	Deaths	931	100%	739	100%	126	100%	66 (61)	100%
Cold months	Incidents	354	49%	267	48%	49	40%	38 (36)	76%
	Deaths	454	49%	354	48%	50	40%	50 (48)	76%
Transitional months	Incidents	212	29%	162	29%	40	33%	10 (8)	20%
	Deaths	280	30%	224	30%	42	33%	14 (12)	21%
Warm months	Incidents	159	22%	123	22%	34	28%	2 (1)	4%
	Deaths	197	21%	161	22%	34	27%	2 (1)	3%

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating 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, and one case with a generator and another engine-driven tool (lawn mower) in operation.

2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were being used concurrently.

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

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, 2013.

Incidents involving deaths are further summarized in Table 8 by the location where the death occurred. The majority of non-fire, CO poisoning deaths (782 of 931, or 84%) reported to CPSC staff associated with engine-driven tools occurred at home locations. Seventy-two percent of the deaths occurred at fixed-structure used as a residence, which include houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage. Another 10 percent occurred in external structures at home locations, such as detached garages or sheds. And another two percent occurred in nontraditional homes, such as travel trailers, houseboats, or storage sheds used as permanent residences. The “Temporary shelter” category includes incidents in which victims died from CO poisoning from portable generators or other engine-driven tools, while the victims were temporarily occupying trailers, horse trailers, recreational vehicles (RVs), cabins (used as a temporary shelter), tents, and campers. Incidents that occurred in a temporary shelter, where the generator was an integral part of the temporary shelter, such as built-in generators or generators built specifically for use in an RV are not within the purview of the CPSC and thus, out of scope for this report and were excluded from the analyses. The “Boat/Vehicle” category only includes incidents in which a generator or other engine-driven tool was not an integral part of the boat—but was brought onto the boat—and incidents where an EDT was brought into a vehicle, such as a van. As with temporary shelters, incidents involving generators that were built-in or specifically designed for a boat are not within the purview of CPSC and are not included in this report. The “Other” category includes incidents that occurred in the following locations: office buildings, utility buildings, and storage sheds (offsite from home).

**Table 8: Number of Reported Non-Fire Carbon Monoxide Incidents and Fatalities Associated with Engine-Driven Tools by Location, 1999–2012**

Location		Number of Incidents and Deaths Reported to CPSC							
		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>1,2</sup>	
Total	Incidents	725	100%	552	100%	123	100%	50 (45)	100%
	Deaths	931	100%	739	100%	126	100%	66 (61)	100%
Home, fixed Structure <sup>3</sup>	Incidents	516	71%	404	73%	75	61%	37 (35)	74%
	Deaths	666	72%	542	73%	76	60%	48 (46)	73%
Home, detached Structure <sup>4</sup>	Incidents	90	12%	48	9%	38	31%	4 (1)	8%
	Deaths	94	10%	51	7%	39	31%	4 (1)	6%
Home, non-house <sup>5</sup>	Incidents	19	3%	13	2%	4	3%	2 (2)	4%
	Deaths	22	2%	16	2%	4	3%	2 (2)	3%
Temporary shelter	Incidents	65	9%	58	11%	2	2%	5 (5)	10%
	Deaths	99	11%	88	12%	2	2%	9 (9)	14%
Boat/Vehicle	Incidents	19	3%	16	3%	1	1%	2 (2)	4%
	Deaths	26	3%	21	3%	2	2%	3 (3)	5%
Other	Incidents	12	2%	10	2%	2	2%	0 (0)	0%
	Deaths	15	2%	13	2%	2	2%	0 (0)	0%
Not reported	Incidents	4	1%	3	1%	1	1%	0 (0)	0%
	Deaths	9	1%	8	1%	1	1%	0 (0)	0%

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating consumer products, such as (or including) one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves, and one case with a generator and another engine-driven tool (lawn mower) in operation.

2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were used concurrently.

3 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.

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

5 This refers to non-fixed location residences, including travel trailers and houseboats.

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

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, 2013.

Table 9 presents the number of non-fire, CO poisoning deaths reported to CPSC staff and 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). Recently, the four urban/rural categories were changed to delineate further the large urban category. Formerly, the four broad categories were: “Urban,” “Large Rural,” “Small Rural,” and “Isolated.” In the newer categorization, the “Urban” category was divided into “Urban Core” and “Sub-Urban.” Additionally, the “Small Rural” and “Isolated” categories are now combined into the “Small Rural/Isolated” category. Details on the process of determining population density or rurality can be found at the USDA website at: <http://www.ers.usda.gov/briefing/Rurality/>. Additional information regarding the cross-referencing of zip codes to RUCA codes can be obtained from the University of Washington, WWAMI<sup>4</sup> Rural Health Research Center website at: <http://depts.washington.edu/uwruca/>.

Fifty-six percent (518 of 931) of CO fatalities associated with the use of engine-driven tools 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. Forty-four percent (413 of 931) 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. There appears to be an unusually high proportion of fatalities in small rural/isolated areas. Seventeen percent (157 of 931) of the CO fatalities known to CPSC staff to be associated with EDTs occurred in small rural and isolated areas, where only an estimated nine percent of the U.S. population lives. The high proportion of fatalities in small rural/isolated areas can be explained partly by the fact that 22 percent (35 of 157) of these occurred in temporary or boat/vehicle locations and not at home locations.

---

<sup>4</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 Wyoming, Alaska, Montana, and Idaho.

**Table 9: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Population Density of Place of Death, 1999–2012**

Population Density		Estimated Percentage of U.S. Population <sup>1</sup>	Number of Deaths Reported to CPSC							
			All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>2,3</sup>	
Total	Incident	100%	725	100%	552	100%	123	100%	50 (45)	100%
	Deaths		931	100%	739	100%	126	100%	66 (61)	100%
Urban Core	Incident	71%	399	55%	318	58%	62	50%	19 (19)	38%
	Deaths		518	56%	430	58%	63	50%	25 (25)	38%
Sub-Urban	Incident	10%	101	14%	73	13%	17	14%	11 (7)	22%
	Deaths		134	14%	102	14%	17	13%	15 (11)	23%
Large Rural	Incident	10%	102	14%	71	13%	21	17%	10 (9)	20%
	Deaths		122	13%	88	12%	22	17%	12 (11)	18%
Small Rural /Isolated	Incident	9%	123	17%	90	16%	23	19%	10 (10)	20%
	Deaths		157	17%	119	16%	24	19%	14 (14)	21%

1 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.

2 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating consumer products, such as (*or including*) one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves, and one case with a generator and another engine-driven tool (lawn mower) in operation.

3 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were being used concurrently.

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

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, 2013.

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

U.S. Census Bureau, 2011.

### III. Alarm Usage

Table 10 presents a summary of known CO fatalities characterized by CO alarm usage and alarm status. In 62 percent of the fatal incidents (446 of 725) and 59 percent of reported CO poisoning deaths (546 of 931), the presence of a CO alarm at the location of the incident was unknown or unreported. Of the 279 fatal incidents (385 CO fatalities) associated with engine-driven tools in which it was known whether a CO alarm was present or not, a CO alarm was present in only 21 incidents (8%) involving 30 CO fatalities. Of these 21 fatal incidents, the alarm was known to be inoperable in eleven incidents (18 fatalities) due to missing, improperly installed, or possibly drained batteries in a battery-powered alarm (non-plug-in type), or because the alarm was a plug-in type and power was out at the location of the incident. Nine of the eleven fatal incidents (16 fatalities) with inoperable alarms were associated with generator usage.

For the remaining 10 fatal incidents (12 fatalities) where an alarm was known to be present, the alarm was known to have sounded in only six incidents (six deaths). Four of the six incidents occurred in an attached garage of a home with the alarm sounding inside the house. It is unclear from the incident reports, but, presumably, the death occurred in the garage before CO levels increased inside the house sufficient to set off the CO alarm. In one incident, the victim's family reportedly did not understand that the alarm sounding pattern (sounding every few minutes) was indicating CO present in the home; they thought the alarm sounding simply meant that the alarm was working. In another incident, the victim was found in a home where a CO alarm was sounding. It is unclear if the alarm triggered after the victim became incapacitated by CO poisoning or if the victim simply misunderstood or ignored the signal. There were also six deaths from four incidents in which a CO alarm was present in the house, but it was unknown whether it sounded or if it was operable.

**Table 10: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire  
Carbon Monoxide Poisoning Deaths, 1999–2012**

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)			Multiple Products <sup>1,2</sup>		
	Incidents	Deaths	% of Deaths	Incidents	Deaths	% of Deaths	Incidents	Deaths	% of Deaths	Incidents	Deaths	% of Deaths
<b>Total</b>	<b>725</b>	<b>931</b>	<b>-</b>	<b>552</b>	<b>739</b>	<b>-</b>	<b>123</b>	<b>126</b>	<b>-</b>	<b>50 (45)</b>	<b>66 (61)</b>	<b>-</b>
<b>Alarm Status Known</b>	<b>279</b>	<b>385</b>	<b>100%</b>	<b>227</b>	<b>326</b>	<b>100%</b>	<b>32</b>	<b>34</b>	<b>100%</b>	<b>20 (17)</b>	<b>25 (22)</b>	<b>100%</b>
<b>No Alarm</b>	<b>258</b>	<b>355</b>	<b>92%</b>	<b>213</b>	<b>303</b>	<b>93%</b>	<b>29</b>	<b>31</b>	<b>91%</b>	<b>16 (14)</b>	<b>21 (19)</b>	<b>84%</b>
<b>Alarm Present</b>	<b>21</b>	<b>30</b>	<b>8%</b>	<b>14</b>	<b>23</b>	<b>7%</b>	<b>3</b>	<b>3</b>	<b>9%</b>	<b>4 (3)</b>	<b>4 (3)</b>	<b>16%</b>
Alarmed	6	6	2%	1	1	<1%	3	3	9%	2 (2)	2 (2)	8%
Did not alarm, batteries removed or incorrectly inserted	4	8	2%	4	8	2%	0	0	0%	0 (0)	0 (0)	0%
Did not alarm, plug-in type, no power	6	9	2%	4	7	2%	0	0	0%	2 (1)	2 (1)	8%
Non-working, probable drained battery	1	1	< 1%	1	1	< 1%	0	0	0%	0 (0)	0 (0)	0%
Alarm present, Unknown if it alarmed	4	6	2%	4	6	2%	0	0	0%	0 (0)	0 (0)	0%
<b>Alarm Status Unknown</b>	<b>446</b>	<b>546</b>	<b>-</b>	<b>325</b>	<b>413</b>	<b>-</b>	<b>91</b>	<b>92</b>	<b>-</b>	<b>30 (28)</b>	<b>41 (39)</b>	<b>-</b>

1 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating consumer products, such as (or including) one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves, and one case with a generator and another engine-driven tool (lawn mower) in operation.

2 Numbers in parentheses indicate incidents involving a generator and another product, including the case where both a generator and an OEDT (lawn mower) were used concurrently.

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

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, 2013.

## IV. Hazard Patterns Associated with Generators

This section presents information about the usage patterns associated with fatal CO poisoning specific to generators, as well as information about the homes where fatal generator incidents occurred. As of April 23, 2013, CPSC staff is aware of 597 generator-related incidents from 1999 through 2012, which resulted in non-fire CO fatalities. Five hundred and fifty-two of these incidents involved only a generator. The remaining 45 incidents involved a generator and another combustion fuel-burning consumer product, including one that was another engine-driven tool. Staff completed In-Depth Investigations (IDIs) for 570 of 597 (95%) fatal CO incidents associated with generators that occurred from 1999 through 2012. For the remaining 27 incidents in which an IDI was not performed or was not completed by the April 23, 2013 cut-off date, attempts were made to augment the data from reports of the incident in the Injury and Potential Injury Incidents (IPII) records or from death certificate information. Summaries of generator-related incidents in this section also include incidents where multiple fuel-burning consumer products were involved, including a generator.

A review of records for the 597 incidents resulting in 800 generator-related, non-fire CO deaths reported to CPSC staff, which includes 552 incidents (739 fatalities) involving a generator alone and 45 incidents (61 fatalities) involving a generator and another CO-producing consumer product, suggests two main reasons reported for using a generator. One reason cited was to provide electricity to a location that did not have electricity due to a temporary situation (*e.g.*, a power outage), and the other was to provide power after a shutoff to the residence by the utility company due to bill dispute or nonpayment. Table 11 provides a breakdown by year, listing the reasons why a generator was in use at the time of the incident. Twenty-eight percent of the incidents (30 percent of the reported deaths) involving generator-related, non-fire CO fatalities were associated with the use of generators during a temporary power outage stemming from a weather problem or a problem with power distribution. Nineteen percent of the fatal incidents (19 percent of deaths) were associated with the use of generators after a power shutoff by the utility company for nonpayment of a bill or a bill dispute. For 17 percent of the fatal incidents (16 percent of deaths), it could not be determined why the generator was in use, or why there was no electricity at the location of the incident.

**Table 11: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators<sup>1</sup> by Reason for Use, 1999–2012**

Reason for Use		Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	Incidents	597	6	15	17	38	41	35	80	63	58	70	45	36	64	29
	Deaths	800	6	21	23	48	57	47	103	93	71	95	66	45	91	34
Power outage due to weather, or problem with power distribution	Incidents	169	3	1	3	12	15	7	37	11	15	19	10	5	18	13
	Deaths	236	3	1	3	16	20	11	53	17	23	26	17	6	26	14
Electricity turned off by power company due to bill dispute or nonpayment	Incidents	116	0	1	1	10	4	6	11	17	13	13	6	12	17	5
	Deaths	153	0	2	1	13	5	6	12	23	16	19	9	16	25	6
Provide power to storage shed, trailer, boat, camper, cabin, campsite	Incidents	84	0	7	6	5	8	3	8	13	8	5	8	2	7	4
	Deaths	120	0	11	9	7	10	4	11	19	9	7	11	5	12	5
New home or homeowner, and power not yet turned on, home under construction or renovation	Incidents	57	0	1	1	1	4	10	4	6	5	7	5	5	5	3
	Deaths	85	0	1	3	1	8	14	6	9	5	13	6	5	10	4
Provide power to home or mobile home that normally does not have electricity	Incidents	36	0	1	4	1	1	3	6	3	4	4	3	3	2	1
	Deaths	47	0	1	5	1	1	4	6	5	5	5	7	3	2	2
Working on or preparing a home for predicted storm	Incidents	7	1	0	0	0	1	0	0	1	0	4	0	0	0	0
	Deaths	7	1	0	0	0	1	0	0	1	0	4	0	0	0	0
Provide power to a shed or garage that normally does not have electricity	Incidents	9	0	1	1	1	0	0	0	0	0	2	0	1	2	1
	Deaths	9	0	1	1	1	0	0	0	0	0	2	0	1	2	1
Other (previous fire in house, power shut off by owners, servicing power supply, or other usage)	Incidents	16	1	2	1	3	0	0	1	1	0	3	2	1	1	0
	Deaths	19	1	3	1	4	0	0	1	1	0	3	2	1	2	0
Unknown why electricity off	Incidents	103	1	1	0	5	8	6	13	11	13	13	11	7	12	2
	Deaths	124	1	1	0	5	12	8	14	18	13	16	14	8	12	2

<sup>1</sup> 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.

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

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, 2013.

For the 169 fatal incidents associated with a power outage due to weather or a problem with power distribution, Table 12 provides a further breakdown by year and cause of the power outage. Ninety-one percent of the fatal incidents associated with power outages were due to specific weather conditions. Ice or snow storms are associated with the largest percentage of weather-related CO

fatal incidents (46%). Hurricanes are also associated with a large percentage of CO fatal incidents (29%) over the 14-year period from 1999 to 2012. More than 40 percent of the hurricane- or tropical storm-related fatal incidents (20 of 49) occurred in 2005.

**Table 12: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators<sup>1</sup> by Reason for Power Outage, 1999–2012**

Reason for Power Outage		Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	Incidents	169	3	1	3	12	15	7	37	11	15	19	10	5	18	13
	Deaths	236	3	1	3	16	20	11	53	17	23	26	17	6	26	14
Ice or snow storm	Incidents	77	0	0	0	10	5	1	15	6	9	7	9	3	9	3
	Deaths	107	0	0	0	14	7	2	20	8	13	9	14	4	13	3
Hurricane or tropical storm	Incidents	49	0	0	0	1	6	5	20	1	0	6	0	0	3	7
	Deaths	71	0	0	0	1	9	8	31	1	0	8	0	0	5	8
Wind storm	Incidents	7	0	0	1	0	0	0	0	2	1	1	0	0	<i>1</i>	<i>1</i>
	Deaths	11	0	0	1	0	0	0	0	6	1	1	0	0	<i>1</i>	<i>1</i>
Thunderstorm or rainstorm	Incidents	12	0	0	1	0	2	0	1	2	1	1	0	2	2	0
	Deaths	14	0	0	1	0	2	0	1	2	1	2	0	2	3	0
Tornado	Incidents	3	0	0	0	0	0	0	0	0	0	2	0	0	<i>1</i>	0
	Deaths	5	0	0	0	0	0	0	0	0	0	3	0	0	2	0
Storm, unspecified	Incidents	6	0	0	0	0	0	0	0	0	2	1	0	0	<i>1</i>	2
	Deaths	8	0	0	0	0	0	0	0	0	4	1	0	0	<i>1</i>	2
Unknown or other reason for outage	Incidents	15	3	1	1	1	2	1	1	0	2	1	1	0	<i>1</i>	0
	Deaths	20	3	1	1	1	2	1	1	0	4	2	3	0	<i>1</i>	0

<sup>1</sup> 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.

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, 2013.

As shown in Table 8 above, 542 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. Additionally, there were 46 fatalities from multiple product-related incidents involving a generator in a fixed-structure home.

Of these 588 generator-related deaths that occurred in a fixed-structure home, information was available for 499 deaths (85%) regarding the victim's location in relation to the generator. One hundred-thirteen of these 499 fatalities (23%) occurred in the same room or space as the generator.

The 588 deaths that occurred in a fixed-structure home were the result of 439 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, bathrooms, dens, living rooms, landings, home offices, rear rooms, enclosed porches, and converted garages. This category does not include attached garages or basements. The category "Outside the home" includes incidents where the generator was placed outside a home but near an open window, door, or vent of the home. Sixty-seven percent (295 of 439) of the CO fatal incidents at home locations occurred when a generator was placed inside the home, including the living space (139), a basement (108), closet (6), doorway (5), or inside the house, with no further information provided (37). Another 26 percent of the fatal incidents (113 of 439) occurred when the generator was placed in an attached garage, enclosed carport, or attached barn. More than half of the fatal incidents (221 of 439) occurred when the generator was placed in an attached structure (113) or in the basement or crawlspace (108).

Review of the yearly fatal incident data in Table 13 suggests that since 2004, more fatal incidents were related to generators used in non-basement living areas of the home than in any other location category. Included in the definition of "non-basement living area of the home" are the categories "Living Space," "Closet in Home," and "Doorway to Home." Not included is the category, "Inside house, no further information reported," because this could be in the living area or the basement of the house. From 2000 through 2003, there were more fatal CO incidents reported where the generator was placed in the basement or crawl space than in the non-basement living areas (in 1999, there were an equal number of fatalities reported, where generators were placed in the basement and the living area). For the years 2004 through 2012, more reported fatal CO incidents were associated with generators in non-basement living areas than in basement or crawl space locations. Of the 82 generator-associated fatal incidents between 1999 and 2003, the basement was the predominant location of the generator (31 of 82, or 38%), followed by living areas (21 of 82, or 26%), including living space (16), closets (2), and doorways (3), and attached garages and other attached structures (18 of 82, or 22%). From 2004 forward, there have been 357 reported fatal CO incidents in the home associated with the use of generators. More fatal CO incidents occurred with the generators placed in the non-basement living areas (129 of 357, or 36%, including living space (123), closets (4), and doorways (2)), followed by an attached garage or other structure (95 of 357, or 27%), and then the basement (77 of 357, or 22%). It is unclear why there has been a shift from the basement to the living space, but this may indicate a lack of knowledge by consumers about the severity of the CO dangers associated with the use of generators inside the home.

Sixteen deaths were associated with the use of a generator placed outside the home. Usually, this involved placing the generator too near an open window or vent. This category also includes an incident where a generator was running outside the home but inside a building (*e.g.*, outside an apartment but still inside the building).

**Table 13: Non-Fire Carbon Monoxide Poisoning Deaths in the Fixed-structure Home  
Location<sup>1</sup> by Location of the Generator,<sup>2</sup> 1999–2012**

Generator Location		Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	Incidents	439	5	5	8	32	32	28	55	40	44	52	35	29	51	23
	Deaths	588	5	7	10	41	46	38	70	57	56	71	52	35	73	27
Living space (non-basement)	Incidents	139	2	1	2	5	6	12	17	12	15	20	14	13	15	5
	Deaths	184	2	1	2	5	7	18	23	17	19	27	20	13	22	8
Garage / enclosed carport / attached barn	Incidents	113	0	1	2	8	7	6	17	13	10	13	8	5	13	10
	Deaths	143	0	2	2	10	8	8	18	20	15	15	11	6	18	10
Basement / crawl space	Incidents	108	2	3	2	12	12	6	12	9	9	11	6	4	16	4
	Deaths	160	2	4	4	18	20	7	15	11	12	20	11	7	25	4
Inside house, no further information reported	Incidents	37	1	0	1	3	5	1	2	4	6	5	3	1	3	2
	Deaths	43	1	0	1	4	7	1	2	4	6	5	5	2	3	2
Closet in home	Incidents	6	0	0	0	2	0	0	1	1	1	0	1	0	0	0
	Deaths	13	0	0	0	2	0	0	6	3	1	0	1	0	0	0
Outside the home	Incidents	12	0	0	1	0	1	1	4	0	2	0	0	1	1	1
	Deaths	16	0	0	1	0	2	2	4	0	2	0	0	1	2	2
Doorway to home	Incidents	5	0	0	0	2	1	1	0	1	0	0	0	0	0	0
	Deaths	7	0	0	0	2	2	1	0	2	0	0	0	0	0	0
Unknown location, but at home	Incidents	19	0	0	0	0	0	1	2	0	1	3	3	5	3	1
	Deaths	22	0	0	0	0	0	1	2	0	1	4	4	6	3	1

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.

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

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, 2013.

Table 14 presents a summary of non-fire CO fatalities that occurred in the fixed-structure home characterized by ventilation status. Many of the incidents with generator-associated fatalities in the home (193 of the 439 incidents) did not contain information about the ventilation of the generator. In 167 of the 246 incidents (68%), accounting for 227 deaths, in which information on ventilation of the generator was available, there was no ventilation being provided when the incident occurred. In six of these fatal incidents (eight deaths), a window or door was open during some period of use but

later closed. There were 79 incidents associated with generators in which it was reported that some type of ventilation was employed. Of these 79 incidents, 58 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, accounting for 73 CO deaths. As noted here and in Table 13, twelve incidents (16 deaths) were associated with generators that were placed outside the home near open windows, doors, or vents, where carbon monoxide entered the home. In eight incidents (18 deaths), consumers actively attempted to vent generator exhaust outside through a window or door, or through the use of a fan, but these measures failed to adequately vent the CO from the victims' location. An additional fatality occurred when a victim placed a generator outside of an apartment in the unventilated hallway of a building.

**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, 1999–2012**

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>439</b>	<b>588</b>	<b>100%</b>	<b>100%</b>
<b>Some ventilation attempted</b>	<b>79</b>	<b>108</b>	<b>18%</b>	<b>32%</b>
Open window(s), open door(s), an open garage door, or a combination of these	58	73	12%	22%
Actively trying to vent either by fans or by directing exhaust out a window or door	8	18	3%	5%
Placed outside, but near a window, door or A/C unit <sup>3</sup>	12	16	3%	5%
Placed outside apartment, but inside building	1	1	< 1%	< 1%
<b>No ventilation</b>	<b>167</b>	<b>227</b>	<b>39%</b>	<b>68%</b>
Open windows or doors closed sometime later	6	8	1%	2%
No ventilation attempted <sup>4</sup>	161	219	37%	65%
<b>Unknown ventilation</b>	<b>193</b>	<b>253</b>	<b>43%</b>	<b>-</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 incident involved alternately moving the generator outside then inside after the generator would shut off, presumably because of weather conditions. After a warm-up period, the generator was again placed outside until it failed again.

4 One death occurred when a generator was placed outside an apartment in an unvented hallway and one occurred when the generator was placed outside a trailer that was located inside an enclosed, unvented garage.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2013.

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

Table 15 presents a summary of the fatal CO incidents and fatalities characterized by the size of the home in which the fatalities occurred. For 38 percent (166 of 439) of the fatal incidents (217 of 588

deaths), CPSC staff could not ascertain the size of the home. Home size information was available for 273 of 439 fatal incidents (371 of the 588 deaths). Information regarding the size of the home reported in this document is from one of two sources. The first source is the CPSC In-Depth Investigations (IDIs), which include information gathered from police, fire department, or public records. The second source is from Internet databases of real estate information, which contain public record data, such as *Cyberhomes.com* and *Zillow.com*. In most cases, Internet databases agree on the size of the home because both databases are based on public records from the county, state, or municipality. Occasionally, the records in the databases do not agree. In that situation, the average of the two or more sizes was used because it could not be determined which database had the more accurate figure.

Fifty-nine percent (162 of 273) of the reported fatal incidents (225 of 371 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, and 85 percent (233 of 273) of the reported incidents (314 of 371 deaths) occurred in houses that were less than 2,000 square feet. This portion of the fatal incident location includes most incidents that occurred in apartments and mobile homes. Fatal incidents that occurred in a detached structure are not included in this figure. The median home size involved in fatal CO poisoning deaths, where home size information is known, was 1,350 square feet. As a point of reference, according to the U.S. Census Bureau's *American Housing Survey for the United States: 2009*, the median housing unit as of 2009 was 1,736 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, is unclear. Perhaps it is a combination of the two factors, or some yet unidentified reason.

**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, 1999–2012**

Home Size (in sq. feet) <sup>2</sup>	Number of Incidents	Number of Deaths	Percentage of Incidents	Percentage of Incidents Where Home Size is Known	Estimated Percentage of U.S. Housing Units (2009) <sup>4</sup>
<b>Total</b>	<b>439</b>	<b>588</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
Under 500	1	1	< 1%	< 1%	1%
500–999	59	75	13%	22%	10%
1,000–1,499	102	149	23%	37%	25%
1,500–1,999	71	89	16%	26%	24%
2,000–2,499	25	40	6%	9%	17%
2,500–2,999	7	8	2%	3%	9%
3,000 or Larger	8	9	2%	3%	14%
Unknown	166	217	38%	-	-

- 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 the Internet real estate databases, *Cyberhomes.com* and *Zillow.com*.
- 4 The 2009 housing unit figures are the most current figures available.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2013.

U.S. Census Bureau, American Housing Survey for the United States: 2009.

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

The size of the generator and the fuel used with the generator were both examined. The size of the generator was examined by the wattage rating (Table 16). In most cases, the advertised running wattage rating was used to categorize the generator. In some instances, however, a wattage rating was used in which it could not be determined whether it was the rated running wattage or maximum/surge wattage. When the wattage rating of the generator was known or could be determined (385 investigated deaths from 266 incidents), nearly two-thirds of the incidents (174 incidents, 252 deaths) were associated with a generator in the 3500 to 6499 watt rating range. Nearly half (46%) of the incidents (122 incidents, 173 deaths) involving CO fatalities, where the generator size was known, were associated with generators in the 5000 to 6499 watt range.

Almost all of the generators that were involved in the CO poisoning incidents identified in this report were referred to as gas- or gasoline-fueled generators. Four incidents (six deaths) identify a propane-fueled generator as the source of the CO. In all four of these incidents, the generator was identified as non-portable, backup generator.

**Table 16: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Generators<sup>1</sup> Categorized by Generator Wattage Rating, 1999–2012**

Wattage Rating (in Watts)		Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	Incidents	597	6	15	17	38	41	35	80	63	58	70	45	36	64	29
	Deaths	800	6	21	23	48	57	47	103	93	71	95	66	45	91	34
Under 2000	Incidents	19	0	2	0	3	0	2	3	1	2	1	1	2	<i>1</i>	<i>1</i>
	Deaths	23	0	2	0	3	0	2	3	1	5	1	1	2	<i>1</i>	2
2000–3499	Incidents	56	0	3	3	5	2	2	6	9	5	5	3	2	7	4
	Deaths	85	0	5	3	7	3	2	8	17	6	8	6	2	12	6
3500–4999	Incidents	52	0	1	4	1	3	2	10	6	4	9	2	3	6	<i>1</i>
	Deaths	79	0	2	8	1	5	2	13	11	7	11	2	5	11	<i>1</i>
5000–6499	Incidents	122	1	3	3	13	11	11	12	15	9	13	8	10	11	2
	Deaths	173	1	3	4	19	14	18	20	20	9	19	15	12	17	2
6500–7999	Incidents	11	0	0	0	0	0	0	1	0	1	3	1	1	3	<i>1</i>
	Deaths	15	0	0	0	0	0	0	1	0	2	4	1	1	5	<i>1</i>
8000 and larger	Incidents	6	0	0	0	1	0	1	0	1	0	1	1	0	<i>1</i>	0
	Deaths	10	0	0	0	1	0	1	0	1	0	1	1	0	5	0
Not reported	Incidents	331	5	6	7	15	25	17	48	31	37	38	29	18	35	20
	Deaths	415	5	9	8	17	35	22	58	43	42	51	40	23	40	22

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.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2013.

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

## Conclusion

Between 1999 and 2012, there were 931 non-fire CO poisoning deaths from 725 incidents reported to CPSC staff that was associated with engine-driven tools. The majority of these deaths (739) involved generators. Another 61 fatalities were associated with both a generator and another consumer product (one involved both a generator and another engine-driven tool). Other engine-driven tools, 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. Most reported deaths occurred while an individual was at home.

Victims age 25 years and older accounted for about 83 percent of the non-fire CO poisoning deaths that were associated with generators reported to CPSC staff, and the majority (73 percent) of the victims were male. Seventy-four percent of the reported deaths associated with generators (including deaths associated with the use of a generator and another consumer product) occurred at fixed-structure home locations. Sixty-nine percent of the fatalities known to have occurred in the home and involving generators occurred when a generator was placed in the living area or basement of the home. Another 24 percent occurred when a generator was used inside an attached garage or shed.

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, were the single most common reason for generator usage that resulted in a non-fire CO fatality, accounting for at least 236 of the 800 fatalities (30 percent). Generators were often used with little or no ventilation. In only about eight percent of the fatalities was it known that there was a CO alarm installed—and most of these were inoperable at the time of the fatal incident. Conclusions about why consumers used generators indoors or determinations about whether users were aware of the potential non-fire CO-poisoning hazard were not possible to make with the available information.

Victims age 25 years and older accounted for 99 percent of the non-fire CO poisoning deaths reported to CPSC staff that were associated with other engine-driven tools. Males accounted for 97 percent of the deaths associated with other engine-driven tools. Deaths associated with garden tractors and lawn mowers were often associated with an individual repairing or working on the product in an enclosed space.

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, 1999-2011*. U.S. Consumer Product Safety Commission. July 2012.  
<http://www.cpsc.gov/PageFiles/129857/cogenerators.pdf>.

Hnatov, Matthew V. *Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products: 2009 Annual Estimates*. U.S. Consumer Product Safety Commission. December 2012.  
<http://www.cpsc.gov/PageFiles/136146/co12.pdf>

U.S. Census Bureau. American FactFinder. Population, Housing Units, Area, and Density: 2010 - State— 5-digit ZIP Code Tabulation Area: 2010 Census Summary File 1  
<[http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC\\_10\\_SF1\\_GCTPH1.ST09&prodType=table](http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_GCTPH1.ST09&prodType=table)>

U.S. Census Bureau. American Housing Survey for the United States: 2009.  
<<http://www.census.gov/prod/2011pubs/h150-09.pdf>>

U. S. Census Bureau. The 2012 Statistical Abstract - The National Data Book.  
<<http://www.census.gov/compendia/statab/cats/population.html>>

U.S. Department of Agriculture. Briefing Rooms: Measuring Rurality. 7 Nov. 2008  
<<http://www.ers.usda.gov/briefing/Rurality/>>

University of Washington, WWAMI Rural Health Research Center. Guidelines for Using Rural-Urban Classification Systems for Public Health Assessment 15 Feb. 2011

## Appendix A: Epidemiology Data Retrieval Specifics

The queries below were submitted through EPIR (EPIde miology Retrieval), CPSC staff's epidemiology data access application. Query results were reviewed to include only carbon monoxide poisoning incidents and to exclude duplicates and out-of-scope cases, which were cases that did not involve an incident that was associated with a non-fire carbon monoxide exposure and an engine-driven tool. Records from the three databases that were used in this report (the In-Depth Investigation database (INDP), the Injury or Potential Injury Incident database (IPII), and the Death Certificate database (DTHS)) were then manually matched up to provide the most complete record and to eliminate additional duplicates.

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

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

Date of Queries: 05/23/2013

Incident Dates: 1/1/99-12/31/12

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

Diagnosis Codes: 65 (Anoxia), 68 (Poisoning) – (INDP only)

ICD10 Code: X47x, Y17x – (DTHS only)

Narrative/Text Contains: "CARB" or "MONO"

## Appendix B: 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 as it hinders delivery of oxygen to the body. Carboxyhemoglobin data are helpful in estimating the concentration of CO in the product exhaust and the lethality of the product, which affects 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 engine-driven tools.

In healthy adults, a COHb level of 40–50 percent in the blood approximately correlates with symptoms of confusion, unconsciousness, coma, and possible death; a level of 50–70 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 539 of the 931 fatalities (58% of the CO fatalities). Table B-1 shows the frequency of reports by COHb level categories. Percentages in the table are the category proportions of reported COHb levels. Eighty-one percent (436 of the 539) of fatalities had reported COHb levels of 50 percent or greater.

---

<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.

**Table B-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999–2012**

COHb Level	Number of Deaths <sup>1</sup>							
	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)		Multiple Products <sup>2,3</sup>	
<b>Total</b>	<b>931</b>	<b>-</b>	<b>739</b>	<b>-</b>	<b>126</b>	<b>-</b>	<b>66 (61)</b>	<b>-</b>
<b>Reported Levels</b>	<b>539</b>	<b>100%</b>	<b>426</b>	<b>100%</b>	<b>73</b>	<b>100%</b>	<b>40 (35)</b>	<b>100%</b>
Less than 30%	24	4%	19	4%	2	3%	3 (3)	8%
30–39.9%	30	6%	24	6%	5	7%	1 (1)	3%
40–49.9%	49	9%	40	9%	9	12%	0 (0)	0%
50–59.9%	107	20%	88	21%	11	15%	8 (8)	20%
60–69.9%	151	28%	121	28%	18	25%	12 (9)	30%
70–79.9%	136	25%	102	24%	19	26%	15 (13)	38%
80–89.9%	37	7%	27	6%	9	12%	1 (1)	3%
90–99.9%	5	1%	5	1%	0	0%	0 (0)	0%
Not reported	392	-	313	-	53	-	26 (26)	-

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

2 “Multiple Products” includes incidents involving generators or OEDTs with other CO-generating consumer products, such as (*or including*) one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves, and one case with a generator and another engine-driven tool (lawn mower) in operation.

3 Numbers in parentheses indicate incidents involving a generator and another product, including the case where a generator and an OEDT (lawn mower) were used concurrently.

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

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, 2013.