Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 2004–2014

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Executive Summary

This report summarizes non-fire carbon monoxide (CO) incidents associated with engine-driven generators and other engine-driven tools that occurred between 2004 and 2014, and were reported to U.S. Consumer Product Safety Commission ("CPSC") staff as of May 21, 2015. It should be noted that due to incident reporting delays, statistics for the most recent years should be considered incomplete, as data collection is still ongoing. In this report, the two most recent years, 2013 and 2014, are identified as being incomplete because 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 other engine-driven tools, such as power lawn mowers, garden tractors, portable pumps, power sprayers and washers, snow blowers, and concrete saws that were reported to CPSC staff. Additionally 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[1] 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:

- As of May 21, 2015, for the 11-year period 2004 through 2014, 864 fatalities from 673 incidents were associated with the use of engine-driven tools, or engine-driven tools used in conjunction with another potentially CO-emitting consumer product.
- The total number of reported fatalities for 2004 through 2014, had a net increase of 56 from the 808 fatalities summarized in the June 2014 report, including
    - 35 deaths in 2014;
    - new information on 15 deaths for 2013, and five for 2012 that were previously not reported;
    - an additional two deaths were discovered from a 2007 incident that was already reported and that had been erroneously identified as having only one fatality when, in fact, there were three deaths; and
    - one reported fatality, which occurred in 2012, has been removed because newly obtained information identified the associated product as an out-of-scope farm tractor instead of a lawn tractor, as originally identified.
- There were 35 reported non-fire CO fatalities in 2014, from a total of 26 incidents. Twenty-eight of these deaths (20 incidents) involved only a portable generator and no other product; one death involved what appears to be a welder, identified as an installed generator, and used to power a house; four deaths (four incidents) were associated with a non-generator

[1] 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.

other engine-driven tool ("OEDT"); and two deaths (one incident) were associated with multiple fuel-burning consumer products, one was a generator.

- From 2004 to 2014, of the 864 fatalities from 673 incidents:
    - 702 fatalities (81%) from 523 incidents were associated with generators (including five fatalities from three incidents involving fixed location, permanently installed stationary generators);
    - 110 fatalities (13%) from 108 incidents involved other engine-driven tools; and
    - 52 fatalities (6%) from 42 incidents involved multiple fuel-burning consumer products, where one product was either a generator (49 of 52 deaths) or an OEDT (3 of 52 deaths), and the other product was a non-EDT.
- In 41 of the 42 incidents that involved multiple consumer products, the second product involved was either a heating or cooking product. Most commonly, the second product was a portable liquid propane ("LP")- or kerosene-fueled portable heater. The one incident not associated with a heating or cooking product involved a gas-fueled lawn mower and a gas-fueled hedge trimmer.
- Twenty-five percent of the generator-related, non-fire CO incidents (139 of 562) caused multiple fatalities; while only two of the OEDT-related incidents (2%) involved multiple fatalities.

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

- Eighty-three percent of generator-related victims 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.
- Three-quarters of the generator-related, non-fire CO victims were male; while 96 percent (all but four) of the OEDT-related fatalities were male.
- Twenty-four 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 (13%) of the U.S. population. Eighty-eight percent of other engine-driven tool-related, non-fire CO fatalities were non-Hispanic White, much higher than the non-Hispanic White proportion (65%) of the U.S. population.
- Nearly half of generator-related, non-fire CO fatalities (368 of 751) occurred in the four cold months of the year (November through February); while CO fatalities associated with OEDTs were more evenly distributed across the year with the cold months (37%) slightly higher than in the transition and warm months (34% and 29%, respectively).
- Seventy-five percent of the generator-related fatalities occurred in fixed-structure homes; while 71 percent of OEDT fatalities occurred in fixed-structure homes.
- Fifty-eight percent of the EDT-related fatalities are known to have occurred in urban areas. Sixteen 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 258 incidents where alarm presence was known, which accounted for 31 of 354 (9%) EDT-related CO fatalities. In eight of the incidents (15 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 (seven deaths), but the signal was either misunderstood, the alarm was subsequently disarmed (batteries removed after alarming), 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 seven incidents (nine 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:

- Twenty-eight percent of all generator-related, non-fire CO deaths (211 of 751) from 2004 through 2014 were associated with power outages, mostly due to weather-related issues. The two most common causes of weather-related outages leading to fatal incidents were ice/snow storms (74 incidents, 98 deaths) and hurricanes/tropical storms (42 incidents, 61 deaths). The second most common reason for generator usage in the reported CO fatalities was due to power shut-off, accounting for 20 percent (153 deaths from 116 incidents) of the all reported fatalities.
- Five hundred sixty-five non-fire CO fatalities (422 incidents) that occurred in fixed-structure homes were associated with a generator or a generator in use with another potential CO-generating consumer product. Seventy percent (395 deaths, 289 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.
- Two-thirds of generator-related, non-fire fatal CO incidents (66%) in fixed-structure homes (for which information on ventilation of the generator was available) occurred when no ventilation of the generator was attempted.
- Fifty-eight percent of the generator-related, non-fire fatal CO incidents 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; 84 percent occurred in houses less than 2,000 square feet in size.

Carboxyhemoglobin Levels in CO Fatality Victims:

- Of the CO fatality victims associated with engine-driven tools, 80 percent had carboxyhemoglobin (COHb) levels at or above the 50 percent level when the COHb level was known.[2]

Note: Throughout this report, the years 2013 and 2014 are italicized in table headings, indicating that incident and death counts may change as additional information is received due to reporting delays. Incident and death counts may change for other years, but to a much smaller extent.

[2] 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 incidents reported and entered into CPSC databases on or before May 21, 2015. 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 864 non-fire CO fatalities associated with EDTs during the years 2004 through 2014. Last year's report, dated June 2014, contained summary information and analyses for the 10-year period, 2004−2013. Since the last report, there have been 56 new CO fatalities associated with engine-driven tools reported to CPSC. This is an increase of 56 fatalities from the 808 fatalities over the period of 2004−2013 reported in the June 2014 report on non-fire CO fatalities associated with EDTs, which included data entered into CPSC databases as of May 1, 2014.[3]

Changes to previous report:

- 2007 – Two additional fatalities were discovered in police reports of an incident that was originally thought to be a single-fatality incident.
- 2012 – Five new single-fatality incidents added and one single fatality incident was removed having been determined to be out-of-scope based on newly acquired information, for a net change of four total fatalities.
- 2013 – Fourteen new incidents added, accounting for 15 deaths.
- 2014 – Twenty-six incidents added, accounting for 35 deaths.

All but two of the 35 fatalities reported to CPSC that occurred in 2014 were associated with generators or other engine-driven tools ("OEDT") as the only known sources of the CO. Two additional fatalities from a single incident were associated with the use of a generator and a portable kerosene heater.

Incidents associated with generators that were specifically reported as integral parts of recreational vehicles ("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

[3] Hnatov, M. V. *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 2004–2013. U.S. Consumer Product Safety Commission. June 2014.*

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 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 generator usage patterns that may lead to fatal CO poisoning events.

Additionally, Appendix B 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.

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

As of May 21, 2015, CPSC staff had records indicating that there were 26 fatal, non-fire CO exposure incidents involving EDTs between January 1, 2014 and December 31, 2014. Thirty-five deaths occurred in these 26 fatal CO incidents. Table 1 presents the reported fatal incidents and the number of deaths in 2014, along with a summary of CO incidents and fatalities associated with engine-driven tools for the 11-year period from 2004 through 2014. The table records the number of incidents and deaths by the broad categories of "Generators," OEDTs 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 52 fatalities associated with multiple consumer products, occurring between 2004 and 2014; two of these fatalities occurred in 2014. 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. Following Table 1, Multiple Product incidents will be included in the summary for the involved engine-driven tool type, either "Generators" or OEDTs.

Within each broad category, the frequency of reports is summarized by product type. Staff is aware of 673 incidents with a total of 864 deaths due to non-fire CO exposure that occurred between 2004 and 2014, involving EDTs.

In Table 1, the product type "welder" appears in both the "Generator" and OEDT categories. Some welding equipment is designed to be used as a welder or as an electric generator. Three of the fatal, non-fire CO incidents associated with the use of welding equipment that occurred between 2004 and 2014, involved the use of the welder as a generator during a power outage. Each of these three incidents involved a single death. There were three fatal, non-fire CO incidents between 2004 and 2014, which were associated with the use of welder equipment, where it was not specifically identified as being used as a generator. Of these three incidents, one incident involved two deaths.

All but one of the 52 non-fire, CO fatalities in the "Multiple Products" category for 2004–2014 involved a heating- or cooking-related consumer product other than an EDT. The one incident not involving a heating- or cooking-related consumer product 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, 2004–*2014*

Product	*2013*		*2014*		Total: 2004–*2014*	
	Number of Incidents	*Number of Deaths*	*Number of Incidents*	*Number of Deaths*	Number of Incidents	Number of Deaths
Total Engine-Driven Tools	***50***	***62***	***26***	***35***	**673**	**864**
Generators	***39***	***51***	***21***	***29***	**523**	**702**
Generator, portable	*39*	*51*	*20*	*28*	517	694
Generator, fixed	*0*	*0*	*0*	*0*	3	5
Welder (used as a generator)[1]	*0*	*0*	*1*	*1*	3	3
Other Engine-Driven Tools (OEDT)	***7***	***7***	***4***	***4***	**108**	**110**
Lawn mowers	*3*	*3*	*1*	*1*	55	55
Riding lawn mower/Garden tractor	*2*	*2*	*0*	*0*	46	46
Push lawn mower	*0*	*0*	*0*	*0*	2	2
Powered lawn mower, unspecified type	*1*	*1*	*1*	*1*	7	7
Power washer/sprayer	*0*	*0*	*1*	*1*	12	12
Snow blower	*2*	*2*	*1*	*1*	13	13
All-terrain vehicle	*0*	*0*	*1*	*1*	8	9
Welder (used as welder or other reason)[1]	*0*	*0*	*0*	*0*	3	4
Water pump	*1*	*1*	*0*	*0*	5	5
Concrete saw	*0*	*0*	*0*	*0*	2	2
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	*0*	*0*	*0*	*0*	1	1
Stump Grinder	*1*	*1*	*0*	*0*	1	1
Wood Splitter	*0*	*0*	*0*	*0*	1	1
Multiple Products[2]	***4***	***4***	***1***	***2***	**42**	**52**
Generator + Other Consumer Product	*3*	*3*	*1*	*2*	39	49
OEDT + Other Consumer Product[3]	*1*	*1*	*0*	*0*	3	3

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.

3 The two incidents associated with an OEDT and another consumer product includes the following engine-driven tools: one incident involved two gasoline-fueled lawn mowers and an LP heater, and the other incident involving a gasoline-fueled lawn mower and a gasoline-fueled trimmer.

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, 2015.

Five hundred and twenty-three of the 673 incidents (78%) reported to CPSC staff during the 2004−2014 period were associated with a generator and accounted for 702 of the 864 CO deaths (81%). Additionally, 49 other CO fatalities from 39 incidents were associated with the use of a generator and another combustion consumer product—most commonly an LP- or kerosene-fueled heater. 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 engine-drive tool-related CO incidents (58 of 113, 51%) involved a garden tractor or other powered lawn mower (including all three of the 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 673 fatal incidents, 79 percent involved a single fatality. Seventy-five percent (423 of 562) 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 111 fatal incidents in the OEDTs category, two incidents resulted in more than one fatality.

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, 2004–*2014*

Number of Deaths Reported in Incident[1]	All Engine-Driven Tools (EDTs)		Generator		Other Engine-Driven Tools (OEDTs)	
All Incidents	**673**	**100%**	**562**	**100%**	**111**	**100%**
1	532	79%	423	75%	109	98%
2	106	16%	104	19%	2	2%
3	23	3%	23	4%	0	0%
4	9	1%	9	2%	0	0%
5	2	< 1%	2	< 1%	0	0%
6	1	< 1%	1	< 1%	0	0%

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.

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, 2015.

CPSC staff 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 May 21, 2015. 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-eight percent (21 of 56) of the reported fatalities new to the report were for years before 2014.

The average number of non-fire CO fatalities associated with both generators and OEDTs for years 2010 through 2012, is also presented in Table 3. These three years represent the most recent years for which CPSC staff believes reporting are substantially complete. Due to reporting delays, these averages may change slightly in the future, when data are complete. Figure 1 in Appendix C illustrates the historical trend in EDT-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, 2004–*2014*

Year	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
	Incidents	Deaths	Incidents	Deaths	Incidents	Deaths
Total	***673***	***864***	***562***	***751***	***111***	***113***
2004	50	62	35	47	15	15
2005	93	116	80	103	13	13
2006	79	109	63	93	16	16
2007	69	84*	58	73*	11	11
2008	77	102	70	95	7	7
2009	55	76	45	66	10	10
2010	46	57	36	45	10	12
2011	81	108	69	96	12	12
2012	47	53	42	48	5	5
2013	*50*	*62*	*42*	*54*	*8*	*8*
2014	*26*	*35*	*22*	*31*	*4*	*4*
Average: 2010–2012	**58**	**73**	**49**	**63**	**9**	**10**

Notes: Detail averages may not sum to total average due to rounding.
* In previous reports, review of supplemental police record information of an incident that was reported to be a single fatality incident indicated that there were actually three fatalities. Therefore, the number of generator-related fatalities in 2007 was corrected from 71 to 73. This correction is carried through the entire document.
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, 2015.

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 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 85 percent (732 of 864) of reported non-fire, CO poisoning deaths associated with all EDTs. By comparison, according to the 2010 Census, 66 percent of the U.S. population is over 25 years old. Victims with a reported age of 25 years or older accounted for about 83 percent (620 of the 751 victims where the age was known) of non-fire CO poisoning deaths associated with generators and accounted for all but one of the deaths (112 of 113) associated with other EDTs. Eighty-seven percent of the non-fire CO fatalities associated with non-generator, EDTs (98 of 113) involved victims age 45 or older.

It appears from the data summary that EDT-related CO fatalities have been occurring to older consumers at a higher rate. Fifty-six percent of the CO fatalities were over the age of 44, while only 39 percent of the U.S. population was above 44 years of age during this time period. By contrast, only 14 percent of EDT-related victims were below the age of 25, while 34 percent of the U.S. population was below 25 years of age during this time period.

Table 4: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Age of Victim, 2004–*2014*

Age	2010 Estimated U.S. Resident Population[1]	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTS)	
		Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
Total	**100%**	**864**	**100%**	**751**	**100%**	**113**	**100%**
Under 5	7%	11	1%	11	1%	0	0%
5–14	13%	33	4%	33	4%	0	0%
15–24	14%	80	9%	79	11%	1	1%
25–44	27%	248	29%	234	31%	14	12%
45–64	26%	335	39%	278	37%	57	50%
65 and over	13%	149	17%	108	14%	41	36%
Adult, age unknown	-	8	1%	8	1%	0	0%

This percentage represents the 2010 Census estimated percentage of the U.S. population, the approximate mid-point of the 10-year range 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, 2015.
U. S. Census Department, Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: April 1, 2010 to July 1, 2013

Table 5 presents the distribution of the gender of the victims. Male victims accounted for 78 percent of the deaths associated with all EDTs when the gender of the victim is known. Male victims comprised 75 percent of the deaths associated with generators and 96 percent of non-generator, EDT fatalities.

Table 5: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Gender of Victim, 2004–*2014*

Gender	All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)	
	Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
Total	**864**	**100%**	**751**	**100%**	**113**	**100%**
Male	675	78%	566	75%	109	96%
Female	187	22%	183	24%	4	4%
Unknown	2	< 1%	2	< 1%	0	0%

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, 2015.

Table 6 presents a summary of the race/ethnicity of the reported CO fatalities associated with EDTs. The percentage of generator-related CO fatalities identified as “Black/African American” (24% 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 13%). The percentage of the non-generator, EDT-related CO fatalities identified as non-Hispanic “White” (88% of deaths) was much higher than proportion classified as non-Hispanic “White” by of the U.S. Census Bureau (an estimated 65% 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, 2004–*2014*

Race / Ethnicity	2010 Estimated U.S. Resident Population[1]	All Engine-Driven Tools (EDTs)		Generators		All Other Engine-Driven Tools (OEDTs)	
		Deaths	Percentage	Deaths	Percentage	Deaths	Percentage
Total		**864**	**100%**	**751**	**100%**	**113**	**100%**
White	65%	535	62%	435	58%	100	88%
Black/African American	13%	183	21%	180	24%	3	3%
Hispanic (any race)	16%	87	10%	85	11%	2	2%
Asian	5%	14	2%	13	2%	1	1%
Native American	1%	6	1%	6	1%	0	0%
Other / Unknown	< 1%	39	5%	32	4%	7	6%

1 This percentage represents the 2010 Census estimated percentage of the U.S. population, the approximate mid-point of the 10-year range. All categories, with the exception of "Hispanic (any race)" are non-Hispanic averages. Percentages represent single-race figures as multi-race are seldom available from available information. Two percent of the U. S. population identifying themselves as multiracial.

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, 2015.
U. S. Census Department, Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: April 1, 2010 to July 1, 2013

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.

Nearly half (49%) 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.

OEDT-related CO fatalities occur relatively evenly across the year. Thirty-seven percent of the fatalities occurred in the cold months, 34 percent in the transitional months, and 29 percent in the warm months.

Table 7: Number of Reported Non-Fire Carbon Monoxide Incidents and Fatalities Associated with Engine-Driven Tools by Season, 2004–*2014*

Season Incident Occurred		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	**Incidents**	**673**	**100%**	**562**	**100%**	**111**	**100%**
	Deaths	**864**	**100%**	**751**	**100%**	**113**	**100%**
Cold months	Incidents	324	48%	283	50%	41	37%
	Deaths	410	47%	368	49%	42	37%
Transitional months	Incidents	195	29%	158	28%	37	33%
	Deaths	262	30%	224	30%	38	34%
Warm months	Incidents	154	23%	121	22%	33	30%
	Deaths	192	22%	159	21%	33	29%

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, 2015.

Incidents involving deaths are further summarized in Table 8 by the location where the death occurred. The majority of non-fire, CO poisoning deaths (741 of 864, or 86%) reported to CPSC staff associated with EDTs occurred at home locations. Seventy-five percent of the deaths occurred at fixed-structures used as a residence, which include houses, mobile homes, apartments, townhouses, and structures attached to the house, such as an attached garage. Another 8 percent occurred in external or detached structures at home locations, such as detached garages or sheds. A large portion of these external structure fatalities were related to OEDTs, such as lawnmowers running in sheds or detached garages. Thirty-three percent (24 of 72) of fatalities occurring in external structures at the home involved OEDTs.

Three percent of deaths associated with engine-driven tools 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 EDTs, while the victims were temporarily occupying trailers, horse trailers, 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, they are 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 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, 2004–*2014*

Location		All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	**Incidents**	**673**	**100%**	**562**	**100%**	**111**	**100%**
	Deaths	**864**	**100%**	**751**	**100%**	**113**	**100%**
Home, fixed Structure[1]	Incidents	501	74%	422	75%	79	71%
	Deaths	645	75%	565	75%	80	71%
Home, detached Structure[2]	Incidents	70	10%	46	8%	24	22%
	Deaths	72	8%	48	6%	24	21%
Home, non-house[3]	Incidents	20	3%	16	3%	4	4%
	Deaths	24	3%	20	3%	4	4%
Temporary shelter	Incidents	47	7%	47	8%	0	0%
	Deaths	74	9%	74	10%	0	0%
Boat/Vehicle	Incidents	19	3%	18	3%	1	1%
	Deaths	25	3%	23	3%	2	2%
Other	Incidents	13	2%	11	2%	2	2%
	Deaths	16	2%	14	2%	2	2%
Not reported	Incidents	3	< 1%	2	< 1%	1	1%
	Deaths	8	1%	7	1%	1	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.
2 This refers to detached structures at home locations, including detached garages and sheds.
3 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, 2015.

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"). 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[4] Rural Health Research Center website at: http://depts.washington.edu/uwruca/.

Fifty-eight percent (503 of 864) 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. Forty-two percent (361 of 864) of CO fatalities occurred in non-urban core

[4] 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.

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. Sixteen percent (136 of 864) of the CO fatalities known to CPSC staff to be associated with EDTs occurred in small rural and isolated areas, where only an estimated 9 percent of the U.S. population lives.

Table 9: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools by Population Density of Place of Death, 2004–*2014*

Population Density		Estimated Percentage of U.S. Population[1]	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	**Incident**	**100%**	**673**	**100%**	**562**	**100%**	**111**	**100%**
	Deaths		**864**	**100%**	**751**	**100%**	**113**	**100%**
Urban Core	Incident	71%	383	57%	325	58%	58	52%
	Deaths		503	58%	444	59%	59	52%
Sub-Urban	Incident	10%	89	13%	73	13%	16	14%
	Deaths		112	13%	96	13%	16	14%
Large Rural	Incident	10%	96	14%	73	13%	23	21%
	Deaths		113	13%	89	12%	24	21%
Small Rural /Isolated	Incident	9%	105	16%	91	16%	14	13%
	Deaths		136	16%	122	16%	14	12%

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. 2010 is the approximate mid-point year of the 10-year range.

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, 2015.
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 (415 of 673) and 59 percent of reported CO poisoning deaths (510 of 864), the presence of a CO alarm at the location of the incident was unknown or unreported. Of the 258 fatal incidents (354 CO fatalities) associated with EDTs in which it was known whether a CO alarm was present or not, a CO alarm was present in only 21 incidents (9%) involving 31 CO fatalities. Of these 21 fatal incidents, the alarm was known to be inoperable in eight incidents (15 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. All eight fatal incidents (15 fatalities) with inoperable alarms were associated with generator usage.

For the remaining 13 fatal incidents (16 fatalities) where an alarm was known to be present, the alarm was known to have sounded in only six incidents (seven deaths):

- 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 one fatal incident, the victims thought the "beeping" meant that the batteries were low, so they replaced the batteries. The batteries were inserted incorrectly, thus disabling the alarm. One family member died and two survived.
- In one incident, the alarm sounded, and the victim removed the batteries, thus disabling it. The victim was transported to the hospital but was pronounced dead.
- In two incidents, a CO alarm was heard sounding inside the house when the victim was discovered. In both cases, the victims were found inside an attached garage, apparently working on an engine-driven tool (a lawn tractor in one case, and a snow blower in the other), which presumably had been running.
- In another incident, two victims were found in a home in which a CO alarm was sounding. It is unclear if the alarm triggered after the victims became incapacitated by CO poisoning, or if the victims simply misunderstood or ignored the signal.

There were also nine deaths from seven incidents in which a CO alarm was present in the house, but it was unknown whether the alarm sounded or if the alarm was operable.

Table 10: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 2004–*2014*

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
Total	**673**	**864**	**-**	**562**	**751**	**-**	**111**	**113**	**-**
Alarm Status Known	**258**	**354**	**100%**	**227**	**321**	**100%**	**31**	**33**	**100%**
No Alarm	**237**	**323**	**91%**	**210**	**294**	**92%**	**27**	**29**	**88%**
Alarm Present	**21**	**31**	**9%**	**17**	**27**	**8%**	**4**	**4**	**12%**
Alarmed	6	7	2%	4	5	2%	2	2	6%
Did not alarm, batteries removed, incorrectly inserted, or drained	5	10	3%	5	10	3%	0	0	0%
Did not alarm, plug-in type, no power	3	5	1%	3	5	2%	0	0	0%
Alarm present, Unknown if it alarmed	7	9	3%	5	7	2%	2	2	6%
Alarm Status Unknown	**415**	**510**	**-**	**335**	**430**	**-**	**80**	**80**	**-**

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, 2015.

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 May 21, 2015, CPSC staff is aware of 562 generator-related incidents from 2004 through 2014, which resulted in non-fire CO fatalities. Staff completed, or otherwise resolved, IDIs for 533 of 562 (95%) fatal CO incidents associated with generators that occurred from 2004 through 2014. For the remaining 29 incidents in which an IDI was not performed or was not completed by the May 21, 2015 cut-off date, attempts were made to augment the data from reports of the incident in 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 562 incidents resulting in 751 generator-related, non-fire CO deaths reported to CPSC staff suggests two primary 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-seven percent of the incidents (28 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. Twenty-one percent of the fatal incidents (20 percent of deaths) were associated with the use of generators after a power shutoff by the utility company for nonpayment of a bill, a bill dispute, or other reason. For 19 percent of the fatal incidents (18 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.

Most of the generators that were associated with fatal CO poisoning were gasoline-fueled. In 52 of the 562 incidents, the fuel type could not be ascertained. Of the 510 cases where the fuel type used in the generator was known, 99 percent (506 of 510) were gasoline-fueled. Of the remaining incidents, three involved propane-fueled generators, and the other incident involved a diesel-fueled generator.

Table 11: Number of Reported Non-Fire Carbon Monoxide Fatalities for Incidents Associated with Generators[1] by Reason for Use, 2004–*2014*

Reason for Use		Total	2004	2005	2006	2007	2008	2009	2010	2011	2012	*2013*	*2014*
Total	**Incidents**	**562**	**35**	**80**	**63**	**58**	**70**	**45**	**36**	**69**	**42**	***42***	***22***
	Deaths	**751**	**47**	**103**	**93**	**73**	**95**	**66**	**45**	**96**	**48**	***54***	***31***
Power outage due to weather, or problem with power distribution	Incidents	152	7	37	11	15	19	10	5	19	15	*11*	*3*
	Deaths	211	11	53	17	23	26	17	6	27	16	*12*	*3*
Electricity turned off by power company due to bill dispute, nonpayment, or other reason	Incidents	116	6	11	17	13	13	6	12	17	5	*9*	*7*
	Deaths	153	6	12	23	16	19	9	16	25	6	*11*	*10*
Provide power to storage shed, trailer, boat, camper, cabin, campsite	Incidents	65	3	8	13	8	5	8	2	8	5	*4*	*1*
	Deaths	91	4	11	19	9	7	11	5	13	6	*4*	*2*
New home or homeowner, and power not yet turned on, home under construction or renovation	Incidents	59	10	4	6	5	7	5	5	5	3	*6*	*3*
	Deaths	86	14	6	9	5	13	6	5	10	4	*11*	*3*
Provide power to home or mobile home that normally does not have electricity	Incidents	39	3	6	3	4	4	3	3	4	4	*2*	*3*
	Deaths	54	4	6	5	5	5	7	3	4	6	*2*	*7*
Working on or preparing a home for predicted storm	Incidents	5	0	0	1	0	4	0	0	0	0	*0*	*0*
	Deaths	5	0	0	1	0	4	0	0	0	0	*0*	*0*
Provide power to a shed or garage that normally does not have electricity	Incidents	6	0	0	0	0	2	0	1	2	1	*0*	*0*
	Deaths	6	0	0	0	0	2	0	1	2	1	*0*	*0*
Other (previous fire in house, power shut off by owners, servicing power supply, or other usage)	Incidents	11	0	1	1	0	3	2	1	1	1	*1*	*0*
	Deaths	13	0	1	1	0	3	2	1	2	1	*2*	*0*
Unknown why electricity off	Incidents	109	6	13	11	13	13	11	7	13	8	*9*	*5*
	Deaths	132	8	14	18	15	16	14	8	13	8	*12*	*6*

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.

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, 2015.

For the 152 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-three percent of the fatal incidents associated with power outages were known to be due to specific weather conditions. Ice or snow storms are associated with the largest percentage of weather-related CO fatal incidents accounting for nearly half (49%) of the power outage-related incidents. Hurricanes and tropical storms are also associated with 28 percent of CO fatal incidents over the 11-year period from 2004 to 2014. More than half (31 of 61) of the generator-related CO fatalities that were hurricane- or tropical storm-related (20 of 42 fatal incidents) occurred in 2005.

Table 12: Number of Reported Non-Fire Carbon Monoxide Fatalities for Incidents Associated with Generators[1] by Reason for Power Outage, 2004–*2014*

Reason for Power Outage		Total	2004	2005	2006	2007	2008	2009	2010	2011	2012	*2013*	*2014*
Total	**Incidents**	**152**	**7**	**37**	**11**	**15**	**19**	**10**	**5**	**19**	**15**	***11***	***3***
	Deaths	**211**	**11**	**53**	**17**	**23**	**26**	**17**	**6**	**27**	**16**	***12***	***3***
Ice or snow storm	Incidents	74	1	15	6	9	7	9	3	10	5	*8*	*1*
	Deaths	98	2	20	8	13	9	14	4	14	5	*8*	*1*
Hurricane or tropical storm	Incidents	42	5	20	1	0	6	0	0	3	7	*0*	*0*
	Deaths	61	8	31	1	0	8	0	0	5	8	*0*	*0*
Wind storm	Incidents	6	0	0	2	1	1	0	0	1	1	*0*	*0*
	Deaths	10	0	0	6	1	1	0	0	1	1	*0*	*0*
Thunderstorm or rainstorm	Incidents	10	0	1	2	1	1	0	2	2	0	*0*	*1*
	Deaths	12	0	1	2	1	2	0	2	3	0	*0*	*1*
Tornado	Incidents	3	0	0	0	0	2	0	0	1	0	*0*	*0*
	Deaths	5	0	0	0	0	3	0	0	2	0	*0*	*0*
Storm, unspecified	Incidents	7	0	0	0	2	1	0	0	1	2	*1*	*0*
	Deaths	9	0	0	0	4	1	0	0	1	2	*1*	*0*
Unknown or other reason for outage	Incidents	10	1	1	0	2	1	1	0	1	0	*2*	*1*
	Deaths	16	1	1	0	4	2	3	0	1	0	*3*	*1*

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.

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, 2015.

As shown in Table 8 above, 565 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 565 generator-related deaths that occurred in a fixed-structure home, information was available for 474 deaths (84%) regarding the victim’s location in relation to the generator. One hundred and six of these 474 fatalities (22%) occurred in the same room or space as the generator.

The 565 deaths that occurred in a fixed-structure home were the result of 422 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-nine percent (290 of 422) of the CO fatal incidents at home locations occurred when a generator was placed inside the home, including the living space (148), a basement (98), closet (4), doorway (2), or inside the house, with no further information provided (38). Another 26 percent of the fatal incidents (108 of 422) occurred when the generator was placed in an attached garage, enclosed carport, or attached barn. Nearly half (49%) of the fatal incidents (206 of 422) occurred when the generator was placed in an attached structure (108) or in the basement or crawlspace (98).

Fifteen deaths from 11 incidents 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[1] by Location of the Generator,[2] 2004–*2014*

Generator Location		Total	2004	2005	2006	2007	2008	2009	2010	2011	2012	*2013*	*2014*
Total	**Incidents**	**422**	**28**	**55**	**40**	**44**	**52**	**35**	**29**	**54**	**35**	***32***	***18***
	Deaths	**565**	**38**	**70**	**57**	**58**	**71**	**52**	**35**	**76**	**40**	***43***	***25***
Living space (non-basement)	Incidents	148	12	17	12	15	20	17	14	17	9	*8*	*7*
	Deaths	200	18	23	17	19	27	23	14	24	13	*10*	*12*
Garage / enclosed carport / attached barn	Incidents	108	6	17	13	10	13	8	5	13	13	*8*	*2*
	Deaths	140	8	18	20	17	15	11	6	18	13	*12*	*2*
Basement / crawlspace	Incidents	98	6	12	9	9	11	6	5	16	6	*11*	*7*
	Deaths	139	7	15	11	12	20	11	8	25	6	*15*	*9*
Inside house, no further information reported	Incidents	37	1	2	4	5	5	3	4	4	4	*3*	*2*
	Deaths	42	1	2	4	5	5	6	6	4	4	*3*	*2*
Closet in home	Incidents	4	0	1	1	1	0	1	0	0	0	*0*	*0*
	Deaths	11	0	6	3	1	0	1	0	0	0	*0*	*0*
Outside the home	Incidents	12	1	4	0	3	0	0	1	1	1	*1*	*0*
	Deaths	16	2	4	0	3	0	0	1	2	2	*2*	*0*
Doorway to home	Incidents	2	1	0	1	0	0	0	0	0	0	*0*	*0*
	Deaths	3	1	0	2	0	0	0	0	0	0	*0*	*0*
Unknown location, but at home	Incidents	13	1	2	0	1	3	0	0	3	2	*1*	*0*
	Deaths	14	1	2	0	1	4	0	0	3	2	*1*	*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 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, 2015.

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 422 incidents) did not contain information about the ventilation of the generator. In 152 of the 229 incidents (66%), accounting for 213 deaths, in which information on ventilation of the generator was available, there was no ventilation being provided when the incident occurred. In

five of these fatal incidents (seven deaths), a window or door was open during some period of use but later closed. There were 77 incidents associated with generators in which it was reported that some type of ventilation was attempted. Of these 77 incidents, 54 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 67 CO deaths. As noted here and in Table 13, eleven incidents (15 deaths) were associated with generators that were placed outside the home near open windows, doors, or vents, where carbon monoxide entered the home. In twelve incidents (23 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[1] Reported to CPSC Staff and Associated with Generators[2] Categorized by Status of Ventilation, 2004–*2014*

Ventilation Status	Number of Incidents	Number of Deaths	Percentage of Deaths	Percentage of Deaths Where Ventilation is Known
Non-fire CO fatalities in the home	**422**	**565**	**100%**	**100%**
Some ventilation attempted	**77**	**104**	**18%**	**33%**
Open window(s), open door(s), an open garage door, or a combination of these	53	65	12%	21%
Actively trying to vent either by fans or by directing exhaust out a window or door	12	23	4%	7%
Placed outside, but near a window, door or A/C unit[3]	11	15	2%	4%
Placed outside apartment, but inside building	1	1	< 1%	< 1%
No ventilation	**152**	**213**	**38%**	**67%**
Open windows or doors closed sometime later	5	7	1%	2%
No ventilation attempted	147	206	36%	65%
Unknown ventilation	**193**	**248**	**44%**	**-**

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 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, 2015.

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 40 percent (169 of 422) of the fatal incidents and 39

percent of the deaths (220 of 565), CPSC staff could not ascertain the size of the home. Home size information was available for 253 of 422 fatal incidents (345 of the 565 deaths). Information regarding the size of the home reported in this document is from one of two sources. The first source is the CPSC 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. 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.

Fifty-nine percent (150 of 253) of the reported fatal incidents (204 of 345 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 (216 of 253) of the reported incidents and 86 percent of the deaths (295 of 345) 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 generator-related CO poisoning deaths, where home size information is known, was 1,328 square feet. As a point of reference, according to the U.S. Census Bureau's, *American Housing Survey for the United States: 2011,* the median housing unit as of 2010 was 1,800 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[1] Reported to CPSC Staff and Associated with Generators[2] Categorized by Size of Home, 2004–*2014*

Home Size (in sq. feet)[3]	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 (2010)[4]
Total	**422**	**565**	**100%**	**100%**	**100%**
Under 500	2	3	< 1%	1%	1%
500–999	56	76	13%	22%	9%
1,000–1,499	89	125	21%	35%	24%
1,500–1,999	66	91	16%	26%	25%
2,000–2,499	21	32	5%	8%	18%
2,500–2,999	8	9	2%	3%	9%
3,000 or Larger	8	9	2%	3%	14%
Unknown	169	220	40%	-	-

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 2011 housing unit figures represent an approximate mid-point year.

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2015.
U.S. Census Bureau, American Housing Survey for the United States: 2011.

Conclusions

Between 2005 and 2014, 864 non-fire CO poisoning deaths from 673 incidents were reported to CPSC staff that was associated with EDTs. The majority of these deaths (751) involved generators or both 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. 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 (75 percent) of the victims were male. Seventy-five percent of the reported deaths associated with generators occurred at fixed-structure home locations. Sixty-nine percent of the fatal incidents 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 26 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 211 of the 751 fatalities (28 percent). Generators were often used with little or no ventilation. In only about nine percent of the fatalities was it known that there was a CO alarm installed—and many 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 OEDTs. Males accounted for 96 percent of the deaths associated with OEDTs. 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.

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Appendix A: Epidemiology Data Retrieval Specifics

The queries below were submitted through EpiSearch, CPSC staff's epidemiology data access application, accessing data from The Consumer Product Safety Commission Risk Management System ("CPSRMS"). Query results were reviewed to include only non-fire carbon monoxide poisoning fatality incidents related to EDTs and to exclude duplicates and out-of-scope cases, which were cases that were intentional in nature or occurred during a work-related activity.

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 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: 05/21/2015

Incident Dates: 1/1/04-12/31/14
Product Codes: 113, 606, 800-899, 1062, 1400-1464, 3285-3287
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. COHb 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 EDTs.

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.[5] COHb levels were available for 481 of the 864 fatalities (56% 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 percent (385 of the 481) of fatalities had reported COHb levels of 50 percent or greater.

Table B-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 2004–*2014*[1]

COHb Level	All Engine-Driven Tools (EDTs)		Generators		Other Engine-Driven Tools (OEDTs)	
Total	**864**	**-**	**751**	**-**	**113**	**-**
Reported Levels	**481**	**100%**	**419**	**100%**	**62**	**100%**
Less than 30%	24	5%	22	5%	2	3%
30–39.9%	29	6%	25	6%	4	6%
40–49.9%	43	9%	35	8%	8	13%
50–59.9%	102	21%	93	22%	9	15%
60–69.9%	134	28%	118	28%	16	26%
70–79.9%	115	24%	97	23%	18	29%
80–89.9%	29	6%	24	6%	5	8%
90–99.9%	5	1%	5	1%	0	0%
Not reported	383	-	332	-	51	-

1 Percentages shown are the percentage of reported COHb levels per category.
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, 2015.

[5] 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.

Appendix C: 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 2014. The number of generator-related fatalities increased at a steady rate from six in 1999 to 103 in 2005. After which, the number of yearly fatalities has oscillated between 40 and 100 fatalities per year (excluding 2014, which is, however, considered to be incomplete at the time of this report). It should be noted that, due to reporting delays, fatality counts reported in future annual reports for the most recent years are likely to increase. Over the last seven annual reports, including this one, the most recent year's counts have increased by about an average of 28 percent from the previous report. Two years back, the average increase, report to report, is about an additional 9 percent.

The number of CO fatalities associated with the use of non-generators EDTs has been relatively steady over the period 1999 through 2014.

Figure 1: Number of Reported Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Tools, 1999–*2014*