



Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2009

Matthew V. Hnatov
U.S. Consumer Product Safety Commission
Directorate for Epidemiology
Division of Hazard Analysis
4330 East West Highway
Bethesda, MD 20814
September 2010

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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 1999 and 2009, and were reported to the U.S. Consumer Product Safety Commission (CPSC) staff. 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, CO-generating consumer products¹ may have also been involved and the EDT was believed to be, at least, a contributing factor. 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 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 fatalities for 1999 through 2009 increased by 84 from the 592 fatalities summarized in the December 2009 report, which reported fatalities for the period 1999 through 2008.
- Six hundred and seventy-six fatalities from 519 fatal incidents were associated with the use of engine-driven tools, or engine-driven tools used in conjunction with another potentially CO-emitting consumer product, from 1999 through 2009.
- There were 49 non-fire CO fatalities in 2009, from 31 reported incidents. Forty-three of these deaths (25 incidents) were associated with a generator, 4 deaths (4 incidents) were associated with a nongenerator EDT, and 2 deaths (2 incidents) were associated with multiple fuel-burning consumer products, one of which was a generator.
- Five hundred and forty-two (80 percent) of these 676 fatalities from 397 incidents were associated with generators, 86 fatalities (13 percent) from 85 incidents were associated with other engine-driven tools, and 48 fatalities (7 percent) from 37 incidents involved multiple fuel-burning consumer products, one of which was a generator (43 of 48 deaths) or other engine-driven tool (OEDT) (4 of 48 deaths) or both a generator and an OEDT (1 of 48 deaths).
- Of the 37 incidents that involved multiple consumer products, all but one incident involved a heating or cooking product, most commonly a portable LP- or kerosene-fueled portable heater. One incident involved a generator and another EDT (a lawnmower).
- Twenty-seven percent of generator-related non-fire CO incidents caused multiple fatalities, while all but one of the other engine-driven tool-related incidents (99 percent) involved a single fatality. Twenty-four percent of multiple product-related non-fire CO incidents caused multiple fatalities.
- Nearly two-thirds (359 of 542) of generator-related fatalities detailed in this report occurred between 2005 and 2009.

Socio-demographics of Victims and EDT Use Patterns

- Eighty-one percent of generator-related victims were 25 years old or older, while 100 percent of other engine-driven tool-related victims were 25 years old or older.
- Nearly three-quarters of the generator-related non-fire CO victims were male, while all but three of the other engine-driven tool-related fatalities were male (97 percent).
- Nearly half of generator-related non-fire CO fatalities (267 of 542) occurred in the four colder months of the year (November through February), while CO fatalities associated with OEDT

¹ It should be noted that any fuel-burning consumer product has the potential to produce CO because CO is a by-product of incomplete combustion.

were only slightly more prevalent in the colder months (40 percent) than the transitional and warm months (35percent and 26 percent, respectively).

- Eighty-five percent of the generator-related fatalities (including those that occurred when a generator was used alone (83 percent) and when used with another consumer product (2 percent)) occurred at home locations, while 97percent of OEDT fatalities occurred at home locations.
- Eighty-five percent of the generator-related fatalities are known to have occurred in urban or large rural areas and another 15 percent in small rural and isolated areas.

CO Alarm Usage

- A CO alarm was reported to have been present in only 13 of 210 incidents which accounted for 18 of 287 (6 percent) EDT-related CO fatalities where alarm presence was known. In 10 of the incidents, the alarm was inoperable due to either no batteries or no electric current. The alarm sounded in four incidents, and in one incident the alarm was powered, but did not sound. Nine of the 10 fatality cases (six of seven incidents) with inoperable alarms were associated with generator usage.

Hazard Patterns Associated with Generators

- About one-third of all generator-related non-fire CO deaths (186) were associated with power outages. Of these 186 fatalities, 51 (27 percent) occurred in 2005. Twenty-nine of the 2005 fatalities were related to hurricanes or tropical storms, and another 20 were related to ice or snow storms. (Additionally, one fatality was associated with a thunderstorm; and for one fatality, it could not be determined what caused the power outage.)
- Four hundred and eighty-five non-fire CO fatalities which occurred at homes were associated with a generator or a generator in use with another CO generating consumer product. Nearly two-thirds (316 of 485, or 65 percent) 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 living space of the home. From 2004 through 2009, 38 percent of CO fatalities in the home occurred with a generator placed in the living space of the home compared to only 19 percent from 1999 through 2003.
- Seventy percent (196 of 280) of generator-related non-fire CO fatalities at home locations (in which information on ventilation of the generator was available) occurred when no ventilation of the generator was attempted.
- Sixty-two percent (167 of 270) of generator-related non-fire CO fatalities at home locations, 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; 81 percent (218 of 270) occurred in houses less than 2,000 square feet in size.
- Two-thirds (67 percent) of CO fatalities were associated with generators in the 3500 to 6499 watt range, and nearly half (46 percent) were associated with generators in the 5000 to 6499 watt range.

Carboxyhemoglobin Levels in CO Fatality Victims

- More than 82 percent of the engine-driven tools-related CO fatality victims had carboxyhemoglobin (COHb) levels above the 50 percent level.

Note: Throughout this report the year 2009 is italicized in table headings indicating that incident and death counts may change as additional information is received.

Introduction

The following 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 if the incident was in scope for this report and to correct any discrepancies between information from the different sources. 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 June 10, 2010. All fatal 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 676 in-scope CO fatalities associated with EDTs during the years 1999 through 2009. This is an increase of 84 fatalities from the 592 fatalities reported in the December 2009 report on CO fatalities associated with EDTs.² Forty-nine of these occurred in 2009, with the remaining 32 from previous years. Forty-seven of these 49 fatalities were associated with generators or other engine-driven tools (OEDT) as the only known source of the CO gas. Two additional fatalities were associated with multiple, potential CO-producing consumer products, one of which was an EDT, and classified in the 'Multiple Products' category. 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 were considered out of scope and were not included. For example, generators that were reported as mounted to the bottom of an RV were not included, nor were boat generators that were installed by the boat manufacturer. Since incidents in recreational vehicles and boats can be associated with either a portable generator or an integral generator, those incidents in which the type of generator could not be determined were excluded from the analysis.

Any incident that was determined to be other than accidental in nature was considered to be out of scope, as were work-related incidents, which are not within the jurisdiction of the CPSC.

The 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 lethality of the product and the speed of onset of harm.

² Hnatov, M. V. *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2008*. U.S. Consumer Product Safety Commission. December 2009.

I. Reported Numbers of Fatalities by EDT Product Type

As of June 10, 2010, CPSC staff had records indicating that there were 31 fatal non-fire carbon monoxide (CO) exposure incidents involving engine-driven tools between January 1, 2009 and December 31, 2009. Forty-nine deaths occurred in these 31 fatal CO incidents. Table 1 presents the number of fatal incidents and the number of deaths in 2009, along with a summary of CO incidents and fatalities associated with engine-driven tools for the 11-year period from 1999 through 2009. The table reports 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 which 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 48 fatalities associated with multiple consumer products occurring between 1999 and 2009; two of these fatalities occurred in 2009. Incidents involving an EDT and a product that generates CO, but 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 because the source of the fatal CO could not be determined.

It should be noted that fatality and incident counts have changed from the previous report. Prior to the development of this report, CPSC staff undertook a complete search of CPSC databases for EDT-related CO fatality incidents back through 1999, and performed a detailed review of each record. In the process, some new records were identified that were originally omitted due to misclassification or miscoding. Many of these occurred in the 2000 to 2002 date range—all of which were either OEDT incidents or multiple product incidents involving a generator and another fuel-burning consumer product having the potential to produce CO. A small number of incidents included in last year’s report were determined to be out of scope or duplicates of other records and therefore, were removed from the data. Additionally, there was one case (involving two fatalities) which was reclassified from a “Generator” incident to a “Multiple Products” incident because, upon further detailed review, it was determined that two kerosene heaters in addition to a generator were present during the incident, and they could not be ruled out as a contributing factors in the CO poisoning. Finally, information on seven 2008 EDT-related CO fatalities (all generator incidents) became available to CPSC staff since the last report. All 2009 records are new to this report.

Within each broad category, the frequency of reports is summarized by product type. Staff is aware of 519 incidents with a total of 676 deaths due to non-fire CO exposure that occurred between 1999 and 2009 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 either a welder or as a generator alone. Two of the fatal non-fire CO incidents which occurred between 1999 and 2009 involved the use of a welder as a generator during a power outage. There were three other fatal non-fire CO incidents involving a welder. In one incident, involving two deaths, it appears the welder was being used as a source of heat, and, in the other incident, the reason for usage could not be ascertained. These three cases were included in the ‘Other Engine-Driven Tools’ category since there was no evidence that indicated that the welders were being used as generators.

All but one of the 48 non-fire CO fatalities in the ‘Multiple Products’ category involved a heating- or cooking-related consumer product other than an EDT. This incident involved a generator and a lawn tractor being run in a closed garage.

Table 1: Number of Fatal Non-Fire Carbon Monoxide Exposure Incidents and Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-2009

Product	2009		Total: 1999-2009	
	Number of Incidents	Number of Deaths	Number of Incidents	Number of Deaths
Total Engine-Driven Tools	31	49	519	676
Generators	25	43	397	542
Generator	25	43	395	540
Welder (used as a generator) ¹	0	0	2	2
Other Engine-Driven Tools (OEDT)	4	4	85	86
Garden tractor or lawn mower	1	1	54	54
Power washer/sprayer	1	1	7	7
Snow blower	2	2	7	7
All terrain vehicle	0	0	4	4
Welder (used as welder or other reason) ¹	0	0	3	4
Water pump	0	0	3	3
Concrete saw	0	0	3	3
Air compressor	0	0	2	2
Paint Sprayer	0	0	1	1
Small Engine (unknown use)	0	0	1	1
Multiple Products²	2	2	37	48
Generator + other consumer products (excluding OEDTs)	2	2	32	43
OEDT + other consumer products	0	0	4	4
Generator + OEDT	0	0	1	1

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 CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

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, 2010.

Three hundred ninety-seven of the 519 incidents reported to CPSC staff were associated with a generator and accounted for 542 of the 676 CO deaths (80%). Additionally, 44 other CO fatalities from 33 incidents were associated with use of a generator and another consumer product – most commonly an LP- or kerosene-fueled heater. One of these fatalities involved a generator and another engine-driven tool (lawn tractor). Throughout the remainder of this report, incidents associated with all non-generator engine-driven tools are reported as a group. In addition, since the majority of incidents were associated with generators, characteristics of these incidents are reported separately in Section IV. Nearly two-thirds of the non-fire, non-generator CO fatalities (54 of 86) involved a garden tractor or a power lawn mower (including multiple product incidents). Deaths associated with garden tractors and 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 519 fatal incidents, 77% involved a single fatality. Seventy-three percent (291 of 397) of fatal generator-related incidents involved a single fatality. One incident involving a generator resulted in the deaths of six

individuals and another incident involved five fatalities. Of the 85 fatal incidents in the ‘Other Engine-Driven Tools’ category, only one incident resulted in more than one fatality. Twenty-four percent of multiple product fatal CO incidents resulted in multiple fatalities.

Table 2: Number of Fatal Non-Fire Carbon Monoxide Poisoning Incidents Reported to CPSC Staff by Number of Deaths per Incident, 1999-2009

Number of Deaths Reported in Incident¹	Total		Generator		Other Engine-Driven Tools		Multiple Products²	
All Incidents	519	100%	397	100%	85	100%	37	100%
1	403	77%	291	73%	84	99%	28	76%
2	85	17%	77	20%	1	1%	7	19%
3	23	4%	21	5%	0	0%	2	5%
4	6	1%	6	2%	0	0%	0	0%
5	1	< 1%	1	< 1%	0	0%	0	0%
6	1	< 1%	1	< 1%	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). Since 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 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 CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

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 June 10, 2010. 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. For the eleven years covered by this report, 63% (425 of 676) of the deaths were reported in the most recent five years (2005 through 2009).

The average number of non-fire CO fatalities associated with both generators and other engine-driven tools for years 2005 through 2007 is also presented in Table 3. These three years represent the most recent years for which CPSC staff believes reporting to be substantially complete. Due to reporting delays, these averages may change slightly in the future when data are complete. Figure 1 illustrates the trend in generator-related non-fire CO fatalities since 1999.

**Table 3: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff
Associated with Engine-Driven Tools by Year, 1999-2009**

Year	Total	Generators	Other Engine-Driven Tools	Multiple Products¹
<i>Total</i>	<i>676</i>	<i>542</i>	<i>86</i>	<i>48</i>
1999	11	6	5	0
2000	28	20	7	1
2001	25	17	2	6
2002	58	42	9	7
2003	66	51	9	6
2004	63	47	13	3
2005	117	94	14	9
2006	104	86	15	3
2007	66	56	5	5
2008	89	80	3	6
2009	49	43	4	2
Average: 2005-2007	96	79	11	6

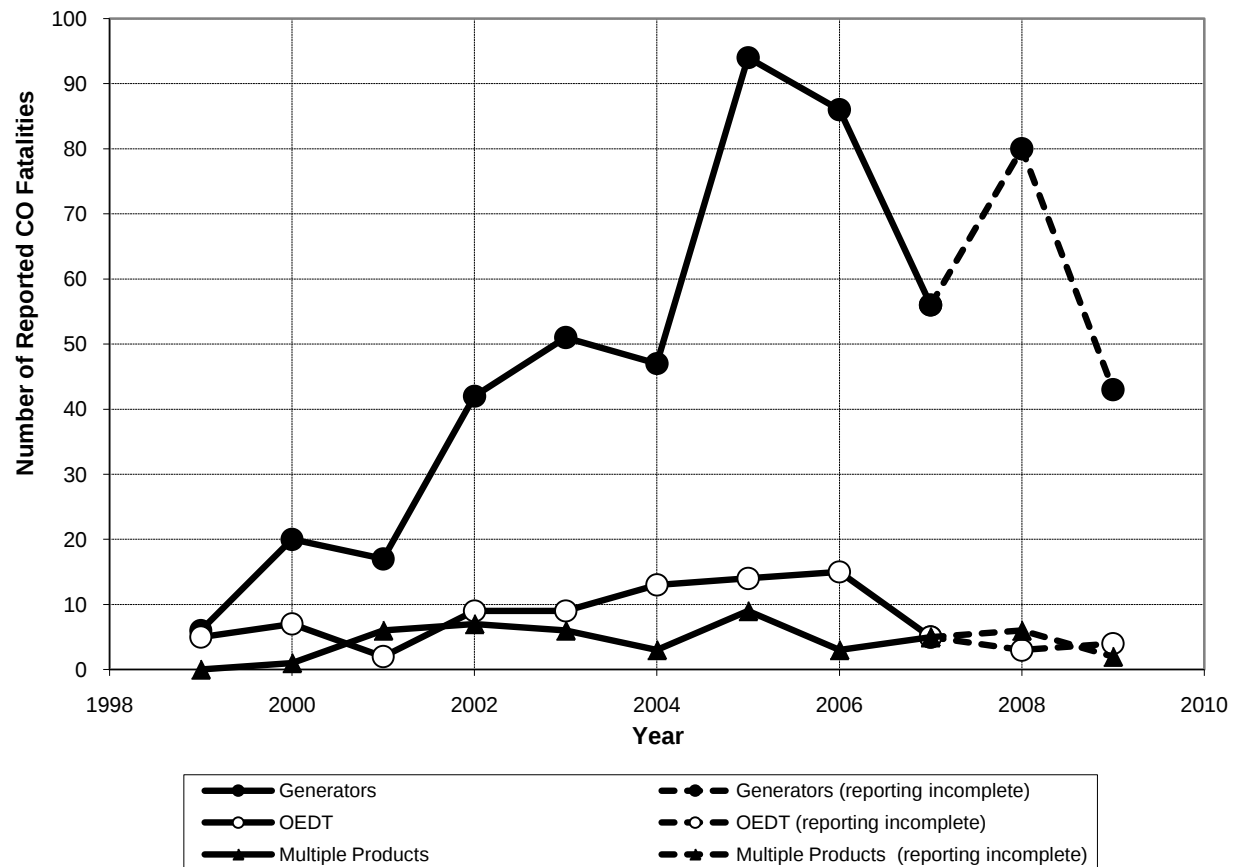
1 'Multiple Products' includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include one or more of the following: portable LP-fueled heaters, portable kerosene-fueled heaters, camp stoves, lanterns, outdoor cookers, furnaces, and wood stoves, and one case with both a generator and another engine-driven tool in operation.

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, 2010.

Figure 1: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-2009



II. Socio-Demographics 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 and 5 present the distribution of age and gender of the victims, respectively. Table 4 shows that victims aged 25 years or older accounted for about 84% (566 of 676) of reported non-fire CO poisoning deaths associated with all engine-driven tools. Victims with a reported age of 25 years or older accounted for about 81% (438 of 542) of non-fire CO poisoning deaths associated with generators and accounted for all deaths associated with other engine-driven tools. Eighty-one percent of the non-fire CO fatalities associated with non-generator engine-driven tools (70 of 86) were aged 45 or older with no reported fatalities of individuals younger than 25. Male victims accounted for 78% of the deaths associated with all engine-driven tools. Male victims comprised 74% of the deaths associated with generators and 97% of non-generator engine-driven tool fatalities (Table 5).

Table 4: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Age of Victim, 1999-2009

Age	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ¹	
Total	676	100%	542	100%	86	100%	48	100%
Under 5	14	2%	14	3%	0	0%	0	0%
5 – 14	24	4%	24	4%	0	0%	0	0%
15 – 24	66	10%	60	11%	0	0%	6	13%
25 – 44	210	31%	182	34%	16	19%	12	25%
45 – 64	250	37%	180	33%	46	53%	24	50%
65 and over	106	16%	76	14%	24	28%	6	13%
Adult, age unknown	6	1%	6	1%	0	0%	0	0%

1 'Multiple Products' includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

Table 5: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Gender of Victim, 1999-2009

Gender	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools		Multiple Products ¹	
Total	676	100%	542	100%	86	100%	48	100%
Male	524	78%	400	74%	83	97%	41	85%
Female	150	22%	140	26%	3	3%	7	15%
Unknown	2	< 1%	2	< 1%	0	0%	0	0%

1 'Multiple Products' includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

Staff examined reported deaths associated with engine-driven tools by the time of year that the incident occurred (Table 6). The non-fire CO fatalities were classified into one of three categories depending on the month in which the victim died: 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 (50%) of the non-fire CO deaths associated with an engine-driven tool 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. Twenty-nine percent of the non-fire 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. Further 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 (35%) and warm months (26%). The *Multiple Products* category had a very large proportion of fatalities in the cold months (79%) with the remaining 21% in the transitional months and no fatalities 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 48 CO fatalities that involved multiple consumer products, all but one 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 6: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Season, 1999-2009

Season Incident Occurred	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ¹	
Total	676	100%	542	100%	86	100%	48	100%
Cold months	339	50%	267	49%	34	40%	38	79%
Transitional months	195	29%	155	29%	30	35%	10	21%
Warm months	142	21%	120	22%	22	26%	0	0%

1 ‘Multiple Products’ includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

Incidents involving deaths are further summarized in Table 7 by the location where the death occurred. The majority of non-fire CO poisoning deaths (85%) reported to CPSC staff that are associated with engine-driven tools occurred at home locations, which included single-family homes, apartments, townhouses, and mobile homes. The home location also includes garages or sheds at homes or 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, 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, were determined to be out of scope for this report and were excluded. 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 considered in scope 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 7: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Location, 1999-2009

Location	Number of Deaths Reported to CPSC							
	All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ¹	
Total	676	100%	542	100%	86	100%	48	100%
Home	572	85%	449	83%	83	97%	40	83%
Temporary shelter	73	11%	65	12%	2	2%	6	13%
Boat/Vehicle	15	2%	12	2%	1	1%	2	4%
Other	10	1%	10	2%	0	0%	0	0%
Not reported	6	1%	6	1%	0	0%	0	0%

1 ‘Multiple Products’ includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

Table 8 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 United States Department of Agriculture (USDA). The four broad categories are Urban, Large Rural, Small Rural, and Isolated.

Details on the process of determining population density, or rurality, can be found at the U.S. Department of Agriculture website at the following URL: <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, WWAMI³ Rural Health Research Center website at the following URL: <http://depts.washington.edu/uwruca/>.

Eighty-five percent (459 of 542) of CO fatalities associated with the use of generators and reported to CPSC staff occurred in urban and large rural areas. The estimated proportion of the U.S. population living in urban and large rural areas is 91%. There appears to be an unusually high proportion of fatalities in small rural and isolated areas. Sixteen percent (108 of 676) 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% of the U.S. population live.

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

Table 8: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Population Density of Place of Death, 1999-2009

Population Density	Estimated Percentage of U.S. Population ¹	Number of Deaths Reported to CPSC							
		All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ²	
Total	100%	676	100%	542	100%	86	100%	48	100%
Urban	81%	481	71%	396	73%	55	64%	30	63%
Large Rural	10%	85	13%	63	12%	15	17%	7	15%
Small Rural	5%	45	7%	30	6%	10	12%	5	10%
Isolated	4%	63	9%	51	9%	6	7%	6	13%
Not reported or Not Applicable	--	2	< 1%	2	< 1%	0	0%	0	0%

1 Estimated 2006 U.S. population categorized by RUCA designation. The 2006 population estimates by RUCA classification are the most recent available.

2 'Multiple Products' includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

WWAMI Rural Research Center at the University of Washington

Economic Research Group, USDA.

III. Alarm Usage

Table 9 presents a summary of CO fatalities known to CPSC staff characterized by CO alarm usage and alarm status. In 60% of the fatal incidents (309 of 519) and 58% of reported fatal CO poisoning deaths (389 of 676), the presence of a CO alarm at the location of the incident was unknown or unreported. Of the 210 fatal incidents (287 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 13 incidents (6%) involving 18 CO fatalities. Of these 13 fatal incidents, the alarm was known to be inoperable in seven incidents (10 fatalities) due to missing batteries from 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. Six of the seven fatal incidents (nine fatalities) with inoperable alarms were associated with generator usage.

For the remaining six fatal incidents (eight fatalities) where an alarm was known to be present, the alarm was known to have sounded in only four incidents (four deaths). Three of the four incidents occurred in an attached garage of a home with the alarm sounding inside the house. In the fourth 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 and thought it simply meant that the alarm was working. In an additional CO death, an apparently operable CO alarm failed to sound even though lethal levels of CO were present in the home. There were also three deaths in one incident in which a CO alarm was present in the house, but it was unknown if it sounded or if it was even operable.

Table 9: Carbon Monoxide Alarm Usage Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999-2009

CO Alarm Status	Number of Deaths and Percentage of Deaths when Alarm Status was Known							
	All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ¹	
Total	676	-	542	-	86	-	48	-
Alarm Status Known	287	100%	243	100%	24	100%	20	100%
No Alarm	269	94%	229	94%	22	92%	18	90%
Alarm Present	18	6%	14	6%	2	8%	2	10%
Alarmed	4	1%	1	< 1%	2	8%	1	5%
Did not alarm, batteries removed	2	1%	2	1%	0	0%	0	0%
Did not alarm, plug-in type, no power	8	3%	7	3%	0	0%	1	5%
Did not alarm, though powered	1	< 1%	1	< 1%	0	0%	0	0%
Alarm present, Unknown if it alarmed	3	1%	3	1%	0	0%	0	0%
Alarm Status Unknown	389	-	299	-	62	-	28	-

1 'Multiple Products' includes incidents involving generators or OEDTs with other CO generating consumer products. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

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 June 10, 2010, CPSC staff is aware of 430 generator-related incidents in 1999 through 2009 that resulted in non-fire CO fatalities. Three hundred-ninety seven of these incidents involved only a generator. The remaining 33 incidents involved a generator and another consumer product, including one that was another engine-driven tool. Staff completed 414 of 430 (96%) In-depth Investigations (IDIs) related to the fatal CO incidents associated with generators that occurred from 1999 through 2009. For the remaining 16 incidents in which an IDI was not performed, 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 with one being a generator.

A review of records for the 586 generator-related non-fire CO deaths reported to CPSC staff, which includes 542 fatalities involving a generator alone and 44 involving a generator and another CO

producing consumer product, suggests two main reasons reported for using a generator. One 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 to a temporary location. Table 10 provides a breakdown by year of the reasons why a generator was in use at the time of the incident. Nearly one-third (32% or 186 of the 586 reported deaths) of the generator-related non-fire CO fatalities involved the use of generators during a temporary power outage stemming from a weather problem or a problem with power distribution. One-sixth (17% or 100 deaths) of the fatalities were associated with the use of generators after power was shut off to the residence by the utility company. For 89 of the reported fatalities (15%) it could not be determined why the generator was in use or why there was no electricity at the location of the incident.

Table 10: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators¹ by Reason for Use, 1999-2009

Reason for Use	Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	586	6	21	23	48	56	48	103	89	61	86	45
Power outage due to weather or problem with power distribution	186	3	1	3	16	19	12	51	16	24	23	18
Electricity turned off by power company due to bill dispute or nonpayment	100	0	1	1	13	5	6	14	23	15	17	5
Provide power to storage shed, trailer, boat, camper, cabin, campsite	89	0	11	9	7	10	4	11	19	7	7	4
New home or homeowner and power not yet turned on, home under construction or renovation	60	0	1	3	1	8	14	6	9	2	12	4
Provide power to home or mobile home which normally does not have electricity	35	0	1	5	1	1	4	6	5	4	6	2
Working on or preparing a home for predicted storm	7	1	0	0	0	1	0	0	1	0	4	0
Provide power to a shed or garage which normally does not have electricity	4	0	1	1	1	0	0	0	0	0	1	0
Other (previous fire in house, power shut off by owners, servicing power supply, or other usage)	16	1	4	1	4	0	0	1	1	0	3	1
Unknown why electricity off	89	1	1	0	5	12	8	14	15	9	13	11

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% 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, 2010.

For the 186 fatalities associated with a power outage due to weather or a problem with power distribution, Table 11 provides a further breakdown by year and cause of the power outage. Ninety percent (167 of 186) of the fatalities associated with power outages were due to outages caused by specific weather conditions. Ice or snow storms are associated with the largest percentage of weather-related CO fatalities

(46%). Hurricanes are also associated with a large percentage of CO fatalities (30%). Table 11 suggests the spike in fatalities in 2005 (shown in Table 10), from 48 in 2004 to 103 in 2005, appears to be due primarily to unusually severe weather. In 2004, there were 12 power outage-related CO fatalities, 11 of these were known to be weather-related. In 2005, the number of power outage-related fatalities jumped to 51, with 50 known to be weather-related. The 50 fatalities associated with weather-related power outages in 2005 were due primarily to hurricanes in September in the Gulf states, ice/snow storms in January in the Midwest, and ice storms in December in the Carolinas. CPSC staff is aware of 29 hurricane- or tropical storm-related non-fire CO fatalities in 2005, more CO deaths than for any other year in this report for all weather-related outages combined. An additional 20 fatalities were associated with the use of generators during ice- or snow-related power outages in 2005. Both the hurricane- and ice/snow-related fatality counts in 2005 are higher than any other year in this report. Over the eleven-year period covered by this report, more than one quarter (26%, 49 of 186) of the power outage-related non-fire CO fatalities occurred during hurricane- or winter storm-related power outages in 2005. Figure 2 illustrates the impact of the power outages in 2005 relative to other years.

Table 11: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators¹ by Reason for Power Outage, 1999-2009

Reason for Power Outage	Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	186	3	1	3	16	19	12	51	16	24	23	18
Ice or snow storm	86	0	0	0	14	7	2	20	8	13	7	15
Hurricane or tropical storm	55	0	0	0	1	8	9	29	1	0	7	0
Wind storm	9	0	0	1	0	0	0	0	5	2	1	0
Thunderstorm	9	0	0	1	0	2	0	1	2	1	2	0
Tornado	3	0	0	0	0	0	0	0	0	0	3	0
Storm, unspecified	5	0	0	0	0	0	0	0	0	4	1	0
Unknown or other reason for outage	19	3	1	1	1	2	1	1	0	4	2	3

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, 2010.

Figure 2: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators During Power Outages

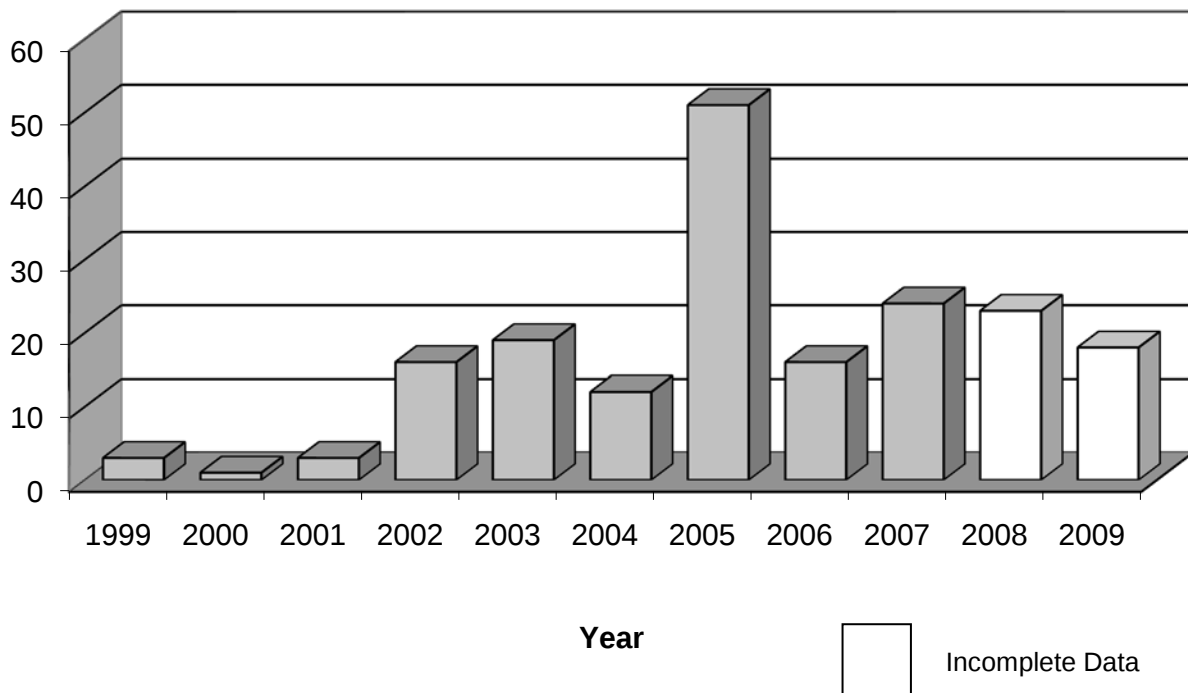


Table 7 shows 449 generator-related non-fire CO fatalities which occurred in the home. Additionally, 36 of the 40 multiple product-related fatalities involved a generator. Of these 485 generator-related fatalities that occurred in a home, information was available for 422 deaths (87%) regarding the victim's location in relation to the generator. One hundred twenty-six of these 422 fatalities (30%) occurred in the same room or space as the generator.

The 485 deaths that occurred in the home were further classified by the specific location of the generator (Table 12) within the home. The category 'Living space' includes rooms reported as bedrooms, bathrooms, dens, living rooms, landings, offices, rear rooms, enclosed porches, and converted garages. This category does not include attached garages or basements. The category 'Outside home' includes incidents where the generator was placed outside a home but near an open window, door, or vent of the home. Sixty-five percent (316 of 485) of the CO deaths at home locations occurred when a generator was placed inside the home including the living space (142), a basement (123), closet (12), doorway (6), or inside the house, with no further information provided (33). Another 23% (110 of 485) occurred when the generator was placed in an attached garage, enclosed carport, or attached barn. Almost half of the CO fatalities (233 of 485) occurred when the generator was placed in an attached structure (110) or in the basement or crawlspace (123).

Review of the yearly fatal incident data in Table 12 suggests that since 2004 more fatalities were related to generators in non-basement living areas of the home. Included in the definition of "non-basement living area of the home" are the categories "Living space", "Closet of home", and "Doorway of home". Not included here is the category "Inside house, no further information reported" since this could be either in the living area or the basement of the house. In each of the four years prior to 2004, there were more CO fatalities 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 each of the years 2005 through 2009, more reported CO fatalities were associated with generators in non-basement living areas than in basement or crawl space locations. Of the 125 generator associated fatalities between 1999 and 2003, the basement was the predominant location of the generator in the fatal CO poisoning incidents (50 of 125, or 40%) followed by living areas 24 of 125, or 19%, including living space (18), closets (2), and doorways(4)) and attached garages and other attached structures (23 of 125, or 18%). From 2004 onward, there have been 360 reported CO fatalities in the home associated with the use of generators. More CO fatalities occurred with the generators placed in the non-basement living areas (136 of 360, or 38%, including living space (124), closets (10), and doorways (2)) followed by an attached structure (87 of 360, or 24%) and then the basement (73 of 360, or 20%). 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.

Table 12: Non-Fire Carbon Monoxide Poisoning Deaths in the Home by Location of the Generator¹, 1999-2009

Generator Location	Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	485	6	14	15	44	46	40	83	68	55	75	39
Living space	142	2	2	2	5	7	18	26	20	19	26	15
Garage / enclosed carport / attached barn	110	0	3	2	10	8	8	19	20	18	15	7
Basement / crawlspace	123	2	6	4	18	20	7	15	11	10	19	11
Inside house, no further information reported	33	1	2	1	4	6	2	4	4	3	3	3
Shed / detached garage / detached workshop	34	1	1	5	2	2	1	6	8	2	5	1
Closet in home	12	0	0	0	2	0	0	6	3	1	0	0
Outside home	10	0	0	1	0	1	3	4	0	1	0	0
Doorway to home	6	0	0	0	2	2	0	0	2	0	0	0
Inside structure, outside apartment or trailer	3	0	0	0	1	0	0	1	0	1	0	0
Unknown location, but at home	12	0	0	0	0	0	1	2	0	0	7	2

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% 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, 2010.

Table 13 presents a summary of non-fire CO fatalities that occurred in the home characterized by ventilation status. Many of the incidents of generator-associated fatalities in the home (205 of the 485 deaths) did not contain information about the ventilation of the generator. In 196 of the 280 deaths (70%) in which information on ventilation of the generator was available, the generators were not vented at the time of the incident. In eight of these deaths, a window or door was open during some period of use but later closed. There were 84 deaths associated with generators that reported that some type of ventilation was employed. Of these 84 deaths, 59 non-fire CO deaths were associated with incidents which reported an open or partially open window, door, garage door, or a combination of these. Twelve deaths were associated with generators that were placed outside the home near open windows, doors, or vents where

carbon monoxide entered the home. In 13 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.

Table 13: Non-Fire CO Fatalities Associated with Generators¹ in the Home Categorized by Status of Ventilation, 1999-2009

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	358	485	100%	100%
Some ventilation attempted	68	84	17%	30%
Open window(s), open door(s), an open garage door, or a combination of these	49	59	12%	21%
Actively trying to vent either by fans or by directing exhaust out a window or door	8	13	3%	5%
Placed outside, but near a window, door or A/C unit ²	11	12	2%	4%
No ventilation	148	196	40%	70%
Open windows or doors closed sometime later	6	8	2%	3%
No ventilation attempted	142	188	39%	67%
Unknown ventilation	142	205	42%	-

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

2 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. Also included here is one death that occurred when a generator was placed outside an apartment in an unvented hallway and one that occurred when placed outside a trailer which was inside an enclosed, unvented garage.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2010.

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

Table 14 presents a summary of the fatal CO incidents and fatalities characterized by the size of the home in which the fatalities occurred. For this characterization, a home is defined as a permanent, fixed residential structure including detached and attached houses, apartments, fixed mobile homes, and cabins. Travel trailers, campers, and RVs are not included in this classification. For 35% (169 of 485) of the deaths, CPSC staff could not ascertain the size of the home. Home size information was available for 270 of the 485 deaths. Additionally, another 9% (46 of 485) of the CO fatalities occurred in a detached structure on the residential property such as a detached garage or shed. 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 one of two internet databases of real estate information which contains public record data: *Cyberhomes.com* and *Zillow.com*. The majority of the time, these two databases agree on the size of the home since both are based on public records from the county, state, or municipality. Occasionally,

the records in the databases do not agree. In these cases, the average of the two size figures was used since it could not be determined which database had the more accurate figure.

Sixty-two percent (167 of 270) of the reported CO fatalities associated with generators that occurred in the home, in which the size of the structure was known, occurred in homes less than 1,500 square feet in size and 81% (218 of 270) occurred in houses less than 2,000 square feet. This portion of the fatal incident locations includes most incidents which 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 1,300 square feet. As a point of reference, according to the U.S. Census Bureau's *American Housing Survey for the United States: 2007*, the median housing unit in 2007 was 1,769 square feet. Comparing the percentages of deaths by home size to the U.S. Census figures, it appears that the CO fatalities are skewed toward smaller homes. Whether this is due to economic reasons or that smaller volume structures are more quickly filled by deadly carbon monoxide is unclear. Perhaps it is a combination of the two factors or some yet unidentified reason.

Table 14: Non-Fire CO Fatalities Associated with Generators¹ in the Home Categorized by Size of Home, 1999-2009

Home Size (in sq. feet) ²	Number of Incidents	Number of Deaths	Percentage of Deaths	Percentage of Deaths Where Size is Known	Estimated Percentage of U.S. Housing Units (2007)
Total	360	485	100%	100%	100%
Under 500	4	6	1%	2%	1%
500-999	55	73	15%	27%	11%
1,000-1,499	62	88	18%	33%	25%
1,500-1,999	40	51	11%	19%	24%
2,000-2,499	25	39	8%	14%	17%
2,500-2,999	5	6	1%	2%	9%
3,000 or Larger	6	7	1%	3%	13%
Unknown	122	169	35%	-	-
Detached Structure	41	46	9%	-	-

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

2 Home Size based on CPSC IDIs or from the internet real estate databases *Cyberhomes.com* and *Zillow.com*.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2010.

U.S. Census Bureau, *American Housing Survey for the United States: 2007*, Sept. 2008.

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 15). In most cases, the running wattage rating was used to categorize a case. In some instances, however, a wattage rating was obtained, but it could not be determined whether this rating was the rated running wattage or maximum/surge wattage. When the wattage rating of the generator was known or could be determined (287 investigated deaths), 192 deaths (67%) were associated with a generator in the 3500 to 6499 watt rating range. Nearly half (46%) of the CO fatalities where the generator size was known were associated with generators in the 5000 to 6499

watt range. Generator sales data available to CPSC staff⁴ indicate that during the time period 2003 through 2005, 56% of portable generators sold to consumers were in the 3500 to 6499 watt range, 23% of units sold had outputs below 3500 watts, and 21% had outputs of 6500 watts or greater. During this same period, generator size is available for incidents associated with 92 fatalities. Seventy-eight percent (72 of 92) of the CO fatalities were associated with generators in the 3500 to 6499 watt range, 20% (18 of 92) were associated with units with outputs below 3500 watts, and 2% (2 of 92) were associated with units with outputs of 6500 watts or greater. In the time period following the sales data (2006 through 2009), there were 135 fatalities in which the generator size is known. Of these, 61% (82 of 135) of CO fatalities were associated with generators in the 3500 to 6499 watt range, 33% (44 of 135) were associated with units with outputs below 3500 watts, and 7% (9 of 135) were associated with units with outputs of 6500 watts or greater. Assessments of trends or patterns using direct comparisons of sales data and CO fatality data should be made with caution. Sales figures only reflect the proportion of newly purchased generators in each category and do not reflect the proportions of existing generators in the consumer population. Though many CO fatalities are associated with first-time users of newly purchased generators, many are also associated with older generators originally purchased for other uses or borrowed when a need for power presented itself.

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. One generator was identified as a propane-fueled generator, and one was identified as a natural gas-fueled generator.

Table 15: Non-Fire CO Fatalities Associated with Generators¹ Categorized by Generator Wattage Rating, 1999-2009

Wattage Rating (in Watts)	Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	586	6	21	23	48	56	48	103	89	61	86	45
Under 2000	19	0	3	0	3	0	2	3	1	5	1	1
2000 – 3499	64	0	5	3	7	3	2	8	16	6	8	6
3500 – 4999	60	0	2	8	1	5	2	13	11	7	10	1
5000 – 6499	132	1	3	4	19	14	18	20	20	7	16	10
6500 – 7999	7	0	0	0	0	0	0	1	0	2	4	0
8000 and larger	5	0	0	0	1	0	1	0	1	0	1	1
Not reported	299	5	8	8	17	34	23	58	40	34	46	26

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, 2010.

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

⁴ Smith, Charles L. *Portable Electric Generator Sets for Consumer Use: Additional Data on Annual Sales, Number in Use, and Societal Costs*. Memorandum to Janet Buyer, Project Manager, ESFS. August 24, 2006.

Conclusion

Between 1999 and 2009, there were 676 non-fire CO poisoning deaths reported to CPSC staff that were associated with engine-driven tools. The majority of these deaths (542) involved generators. Another 44 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 aged 25 years and older accounted for about 81% of non-fire CO poisoning deaths reported to CPSC staff that were associated with generators, and the majority (74%) were male. Eighty-three percent of the reported deaths associated with generators (including deaths associated with the use of a generator and another consumer product) occurred at home locations. Nearly two-thirds (65%) of the fatalities known to have occurred in the home involving generators occurred when a generator was placed in the living area or basement of the home. Another 23% 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 which resulted in a non-fire CO fatality, accounting for at least 186 of the 586 fatalities (32%). Generators were often used with little or no ventilation. In only about 6% 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 are difficult to make with the available information.

Victims aged 25 years and older accounted for all of the non-fire CO poisoning deaths reported to CPSC staff that were associated with other engine-driven tools. Males accounted for all but three of the 85 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 CPSC's Carbon Monoxide Information Center - www.cpsc.gov/info/co/index.html - 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 EPIR (EPIde miology Retrieval), the 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 further eliminate duplicates. Work-related cases were also excluded.

Date of Queries: 06/10/2010

Incident Dates: 1/1/99-12/31/09

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 is 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 how best to address the CO hazard presented by generators and other engine-driven tools.

In healthy adults, a COHb level of 40 to 50% in the blood approximately correlates with symptoms of confusion, unconsciousness, coma, and possible death; a level of 50 to 70% approximately correlates with symptoms of coma, brain damage, seizure, and death; and a level greater than 70% is typically fatal⁵. COHb levels were available for 392 of the 676 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-two percent (321 of the 392) of fatalities had reported COHb levels of 50% or greater.

Table B-1: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999-2009

COHb Level	Number of Deaths ¹							
	All Engine-Driven Tools		Generators		Other Engine-Driven Tools		Multiple Products ²	
Total	676	-	542	-	86	-	48	-
Reported Levels	392	100%	309	100%	52	100%	31	100%
Less than 30%	15	4%	12	4%	1	2%	2	6%
30-39.9%	21	5%	17	6%	3	6%	1	3%
40-49.9%	35	9%	28	9%	7	13%	0	0%
50-59.9%	79	20%	65	21%	8	15%	6	20%
60-69.9%	102	26%	83	27%	11	21%	8	26%
70-79.9%	109	28%	82	27%	14	27%	13	42%
80-89.9%	28	7%	19	6%	8	15%	1	3%
90-99.9%	3	1%	3	1%	0	0%	0	0%
Not reported	284	-	233	-	34	-	17	-

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. Other consumer products include 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 both a generator and another engine-driven tool in operation.

Notes: Totals may not add to 100% 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, 2010.

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.