



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 10, 2007

TO : Janet Buyer
Project Manager, Division of Combustion and Fire Sciences
Directorate for Engineering Sciences

THROUGH: Kathleen Stralka
Director, Division of Hazard Analysis
Directorate for Epidemiology

FROM : Matthew V. Hnatov
Mathematical Statistician, Division of Hazard Analysis
Directorate for Epidemiology

SUBJECT : Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire
Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven
Tools, 1999-2006

This memorandum summarizes non-fire carbon monoxide (CO) incidents associated with engine-driven generators and other engine-driven tools that occurred between 1999 and 2006¹ and were reported to the U.S. Consumer Product Safety Commission (CPSC) staff. Throughout this memorandum, the number of deaths represents a count of the fatalities reported to CPSC staff and entered in the CPSC databases by June 30, 2007. The count is the unweighted number of CO poisoning deaths in the CPSC files associated with generators and other engine-driven tools. Other engine-driven tools (EDT) include power lawn mowers, garden tractors, portable pumps, power sprayers and washers, snow blowers, and concrete saws. This memorandum summarizes the characteristics of non-fire CO poisoning deaths and incidents associated with engine-driven tools that were reported to CPSC staff. This memorandum also provides a more detailed summary of fatal non-fire CO poisoning incidents associated with engine-driven tools found in CPSC's In-depth Investigation (INDP) File.

According to CPSC records (as of June 30, 2007), some of the findings of this report are that during the years 1999 through 2006,

- 391 fatalities from 303 fatal incidents were associated with the use of engine-driven tools,
- 334 (85%) of these fatalities were associated with generators, 57 (15%) were associated with other engine-driven tools,
- 26% of generator-related CO incidents caused multiple fatalities, while 100% of the other engine-driven tool-related incidents involved a single fatality,
- Nearly three-quarters of generator-related fatalities occurred in the most recent four years,

¹ This analysis was prepared by the CPSC staff, has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

- About two-thirds of generator-related CO fatalities occurred in the fall and winter months,
- Over 80% of generator-related victims were 25 years old or older, while 100% of other engine-driven tool-related victims were 25 years old or older,
- Nearly three-quarters of the generator-related fatalities reported to CPSC staff were males, while all but one of the other engine-driven tool-related fatalities were male (98%), and
- About one-third of all generator-related CO deaths (111) were associated with power outages. Of these 111 fatalities, 46 (41%) occurred in 2005 – 28 were related to hurricanes or tropical storms and another 16 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).

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 manually combined and correlated 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 memorandum reflects only those incidents reported and entered into CPSC databases on or before June 30, 2007. All CO incidents found during the database search that were associated with at least one CO fatality were included.

Twenty-seven incidents associated with both an engine-driven tool and another product other than an engine-driven tool (such as a gas space heater or water heater) were considered out of scope for this analysis, since the exact source of the CO could not be determined. 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.

Table 1 shows the number of fatal carbon monoxide exposure incidents and the number of deaths in CPSC files that occurred between January 1, 1999 and December 31, 2006. The table reports the number of incidents and deaths by the broad categories of generators and other engine-driven tools. Within each broad category, the frequency of reports is summarized by product type. Staff found 303 incidents and 391 deaths due to CO exposure that occurred between 1999 and 2006 inclusive involving engine-driven tools.

The product category ‘welder’ appears under both broad categories. Some welding equipment is designed to be used as either a welder or as a generator alone. One of the fatal CO incidents which occurred between 1999 and 2006 involved the use of a welder as a generator during a power outage. There were two other fatal CO incidents involving a welder. In one incident the welder was being used as a welder and, in the other incident, the reason for usage could not be ascertained. These latter two cases were included in the ‘Other Engine-Drive Tools’ category since there was no evidence that indicated that the welders were being used as generators.

Table 1: Number of Fatal Non-Fire Carbon Monoxide Potential Exposure Incidents and Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-2006

Product	Number of Incidents	Number of Deaths
Total Engine-Driven Tools	303	391
Generators	246	334
Generator	245	333
Welder (used as a generator) ¹	1	1
Other Engine-Driven Tools	57	57
Garden tractor and lawn mower	38	38
Power washer/sprayer	6	6
Welder (used as welder or usage unknown) ¹	2	2
Water Pumps	2	2
Concrete saw	2	2
Snow blower	2	2
Air Compressor	2	2
ATV	2	2
Paint sprayer	1	1

¹ Some welding equipment is designed to be used as either a welder or a generator alone with standard power outlets.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Two hundred forty-six of the 303 incidents reported to CPSC staff were associated with a generator and accounted for 334 of the 391 deaths (85%). Throughout the remainder of this memo, incidents associated with all non-generator engine-driven tools will be reported as a group. In addition, since the majority of incidents were associated with portable generators, characteristics of these incidents will be reported separately.

CPSC staff examined the number of deaths associated with each fatal incident (Table 2). Of the 303 fatal incidents, 79% involved a single fatality. Seventy-four percent (182 out of 246) of fatal generator-related incidents involved a single fatality. One incident involving a generator resulted in the deaths of six individuals. Of the 57 fatal incidents in the ‘Other Engine-Driven Tools’ category, all were associated with only a single fatality.

Table 2: Number of Fatal Non-Fire Carbon Monoxide Poisoning Incidents Reported to CPSC Staff by Number of Deaths per Incident, 1999-2006

Number of Deaths Reported in Incident	Total		Generator		All Other Engine-Driven Tools	
All Incidents	303	100%	246	100%	57	100%
1	239	79%	182	74%	57	100%
2	47	15%	47	19%	0	0%
3	12	4%	12	5%	0	0%
4	4	1%	4	2%	0	0%
5	0	0%	0	0%	0	0%
6	1	< 1%	1	< 1%	0	0%

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

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 numbers of deaths reported to CPSC staff as of June 30, 2007. 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. Figure 1 illustrates the apparent upward trend in generator-related CO fatalities since 1999. The average number of non-fire CO fatalities associated with both generators and other engine-driven tools for years 2002 through 2004 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 in the future when data are complete.

Table 3: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff Associated with Engine-Driven Tools By Year, 1999-2006

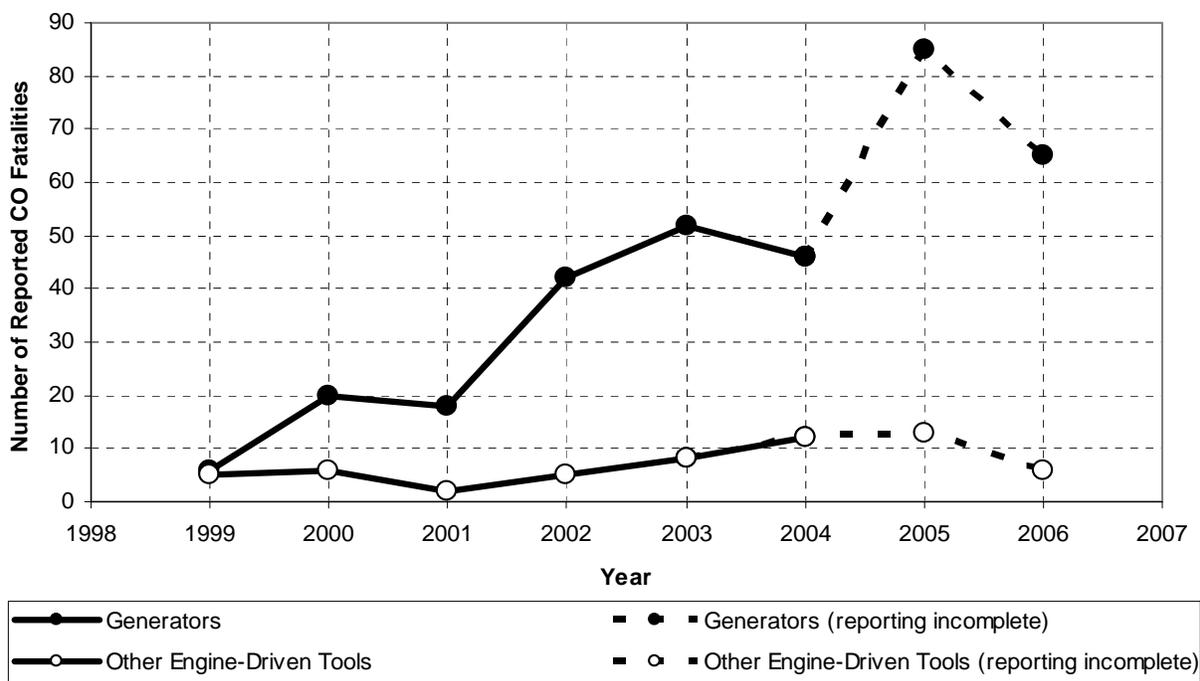
Year	Total	Generators	All Other Engine-Driven Tools
Total	391	334	57
1999	11	6	5
2000	26	20	6
2001	20	18	2
2002	47	42	5
2003	60	52	8
2004	58	46	12
<i>2005</i>	<i>98</i>	<i>85</i>	<i>13</i>
<i>2006</i>	<i>71</i>	<i>65</i>	<i>6</i>
Average: 2002-2004	55	47	8

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

Numbers in italics represent data reported to CPSC staff that may be incomplete due to reporting delays.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Figure 1: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-2006



Staff further examined reported deaths associated with engine-driven tools by the season when the incident occurred (Table 4). Seasons were defined as winter (December, January, and February), spring (March, April, and May), summer (June, July, and August), and fall (September, October, and November).

Table 4: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Season, 1999-2006

Season Incident Occurred	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	391	100%	334	100%	57	100%
Winter	127	32%	114	34%	13	23%
Spring	74	19%	56	17%	18	32%
Summer	66	17%	56	17%	10	18%
Fall	124	32%	108	32%	16	28%

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Sixty-four percent of the deaths associated with an engine-driven tool occurred in the fall and winter months. 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 and hurricanes or

tropical storms. Further details on this issue will be presented later in the analysis of reasons for generator usage during the fatal incidents.

Incidents involving deaths were further summarized in Table 5 by the location where the death occurred. The majority of CO poisoning deaths (81%) reported to CPSC staff and associated with engine-driven tools occurred at a home, 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 trailers, horse trailers, recreational vehicles (RVs), vans, cabins, tents, and campers. The ‘boat’ category only includes incidents in which a generator or other engine-driven tool is not an integral part of the boat but is brought onto the boat. Incidents involving generators that are built-in or specifically designed for a boat are not considered in scope and are not included in this report. This same restriction applies to generators with respect to RVs. The ‘Other’ category includes incidents that occurred in the following locations: office building, utility building and storage shed (offsite from home).

Table 5: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Location, 1999-2006

Location	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	391	100%	334	100%	57	100%
Home	318	81%	266	80%	52	91%
Temporary shelter	52	13%	51	15%	1	2%
Boat	5	1%	5	1%	0	0%
Other	7	2%	7	2%	0	0%
Not reported	9	2%	5	1%	4	7%

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Tables 6 and 7 present the distribution of age and sex of the deceased in the incidents. Table 6 shows that victims age 25 years and older accounted for about 85% of reported CO poisoning deaths associated with all engine-driven tools. Victims age 25 years and older accounted for about 82% of CO poisoning deaths associated with generators and accounted for all deaths associated with other engine-driven tools. Males accounted for 77% of the deaths associated with all engine-driven tools and 74% of the deaths associated with generators. The only female fatality involving a non-generator engine-driven tool was an incident associated with a pressure washer being used to clean a carpet in a pool house.

Table 6: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Age of Victim, 1999-2006

Age	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	391	100%	334	100%	57	100%
Under 5	6	2%	6	2%	0	0%
5 – 14	18	5%	18	5%	0	0%
15 – 24	29	7%	29	9%	0	0%
25 – 44	122	31%	112	34%	10	18%
45 – 64	143	37%	109	33%	34	60%
65 and over	66	17%	53	16%	13	23%
Unknown	7	2%	7	2%	0	0%

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Table 7: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Sex of Victim, 1999-2006

Sex	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	391	100%	334	100%	57	100%
Male	303	77%	247	74%	56	98%
Female	88	23%	87	26%	1	2%

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

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Findings from In-Depth Investigations of Engine-Driven Tool Incidents

Incident data in the CPSC In-depth Investigation File were examined to obtain more detailed information about the scenarios related to CO incidents associated with engine-driven tools. The data are not a statistical sample and national totals may not be derived from the number of incidents investigated. Data provide examples of reported incidents and anecdotal information. Not all information examined is available for each investigation.

CPSC staff conducted in-depth investigations of 281 of the 303 incidents referenced in this memorandum. In-depth investigations associated with generators have been requested more frequently than for other engine-driven tools. From 1999 through 2006, 97% of the incidents associated with generators that were reported to CPSC staff were investigated, while 75% of the incidents involving other engine-driven tools were investigated. In cases where the investigations were not able to provide all of the requested information, attempts were made to augment the data from other sources (i.e., IPII records or death certificates). For those incidents not investigated, attempts were made to gather as much information as was available from these other sources.

In-Depth Investigations Associated with a Fatal CO Poisoning and a Generator

Information provided in in-depth investigation reports that was not available as regularly from the Injury or Potential Injury Incident (IPII) File and Death Certificate (DTHS) File source documents included information about the specific location of the generator, the venting of the generator, the rating of the generator, the fuel used with the generator, the reason the generator was being used, whether the generator was owned by the deceased or a member of the deceased's household, the concentration of CO at the location where the generator was used, and the carboxyhemoglobin (COHb) levels of the deceased.

The two main reasons reported for using a generator were to provide electricity to a location that did not have electricity due to a temporary situation, or to provide power to a temporary location. Table 8 provides a breakdown of the reasons why a generator was in use at the time of the incident. Nearly a third of the 334 generator-related CO fatalities involved the use of generators during a temporary power outage stemming from a weather problem or a problem with power distribution. In 46 cases (14%) it could not be determined why the generator was in use or why there was no electricity at the location of the incident.

Table 8: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators by Reason for Use, 1999-2006

Reason for Use	Number of Deaths	Percentage
Total	334	100%
Power outage due to weather or problem with power distribution	111	33%
Provide power to storage shed, trailer, boat, camper, cabin, campsite	57	17%
Electricity turned off by power company due to bill dispute or nonpayment	53	16%
New home or homeowner and power not yet turned on, home under construction or renovation	35	10%
Provide power to home or mobile home which normally does not have electricity	21	6%
Working on or prep it to work for predicted storm	3	1%
Other (previous fire in house, power shut off by owners, servicing power supply)	8	2%
Unknown why electricity off	46	14%

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

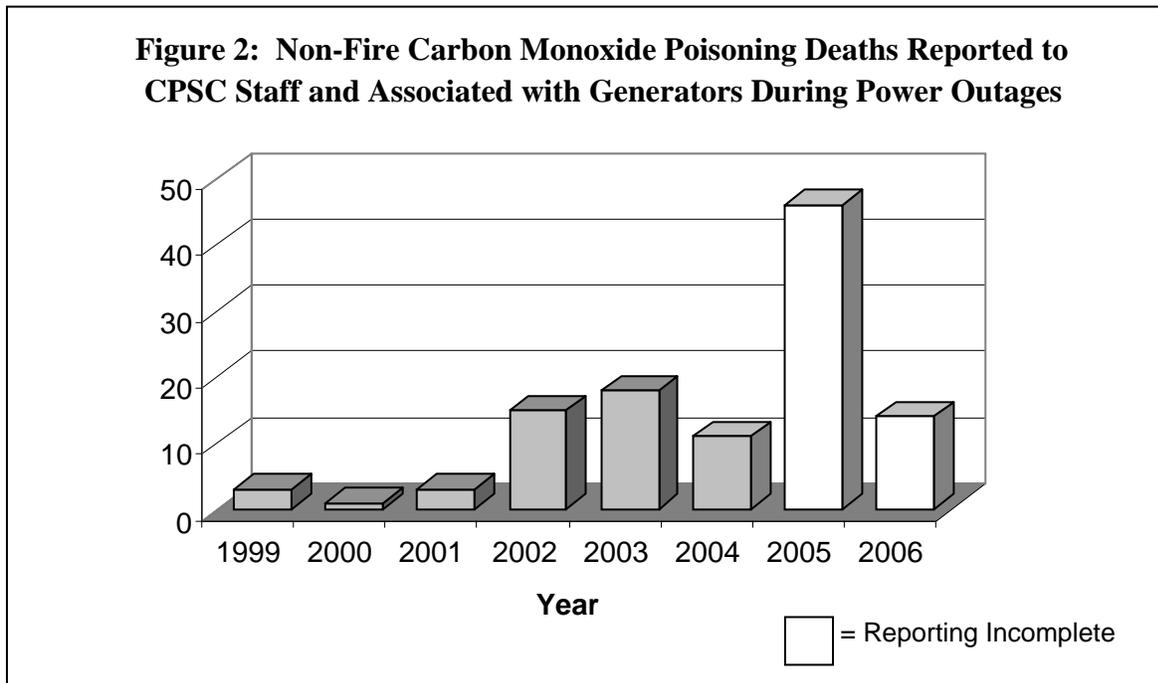
For the 111 fatalities associated with a power outage due to weather or a problem with power distribution, Table 9 provides a breakdown by year and cause of the power. In all but eight fatalities, a weather condition was identified as a cause for the power outage. The number of power outage-related fatalities in 2005 was high due to hurricanes in September in the gulf states and ice/snow storms in January in the Midwest and in December in the Carolinas. CPSC staff is aware of 28 hurricane- or tropical storm-related CO fatalities in 2005, more CO deaths than for

any other year in this report for all weather-related outages combined. Over the eight-year period covered by this report, 41% (46 of 111) of the power outage-related CO fatalities occurred in 2005. Figure 2 illustrates the impact of the power outages in 2005 relative to other years.

Table 9: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators by Reason for Power Outage, 1999-2006

Generator Location	Total	1999	2000	2001	2002	2003	2004	2005	2006
Total	111	3	1	3	15	18	11	46	14
Hurricane or Tropical Storm	47	0	0	0	1	8	9	28	<i>1</i>
Ice or Snow Storm	45	0	0	0	13	7	2	16	7
Thunderstorm	5	0	0	1	0	2	0	<i>1</i>	<i>1</i>
Wind Storm	6	0	0	1	0	0	0	<i>0</i>	5
Unknown Reason for Outage	8	3	1	1	1	1	0	<i>1</i>	<i>0</i>

Note: Numbers in italics represent data reported to CPSC that may be incomplete due to reporting delays.
 Source: U.S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007



For the 334 generator-related non-fire CO fatalities, information was available for 287 deaths (86%) on the victim's location in relation to the generator. Eighty-nine of these 287 fatalities (31%) occurred in the same room or space as the generator, and 198 of the victims (69%) were found in rooms or spaces apart from the generator. Of the 334 generator-related fatalities, there were 47 deaths (14%) in which it could not be determined where the victim was in relation to the generator.

For the 334 generator-related non-fire CO fatalities, 266 (80%) of the fatalities are known to have occurred in a home. For this analysis, a 'home' incident was defined as any incident that occurred at a permanent home residence. An incident that occurred in a detached garage or shed at a home residence was considered a home incident. Incidents that occurred in an RV or trailer while on travel away from the victim's permanent residence were not considered home incidents. Of the 266 CO fatalities that occurred in a home, information was available for 238 deaths (89%) indicating the victim's location in relation to the generator. Seventy-two of the 238 fatalities (30%) occurred in the same room or space of the home as the generator, and 166 of the victims (70%) were found in different rooms or spaces of the home. In some cases, victims were found in rooms located above a basement or in rooms next to or above a garage where the generator was located. Of the 266 home fatalities, there were 28 deaths (11%) where it could not be determined where the victim was in relation to the generator.

Information regarding the 266 non-fire CO deaths that occurred in a home was further classified by the specific location of the generator (Table 10). The category 'Living space' includes rooms reported as bedrooms, bathrooms, dens, living rooms, landings, offices, rear rooms, enclosed porches, and converted garages. 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.

A consumer's reasons for placing a generator indoors, along with a determination of the consumer's awareness of the carbon monoxide hazard associated with the use of a generator in an enclosed space, are difficult to quantify from information provided in an investigation report. The reasons for operating a generator in a certain location were provided in the investigation reports or in other sources for 27 deaths. The most common reason mentioned for using a generator indoors was to muffle the sound (8 deaths). Other reasons for using a generator indoors included: the user feared that someone might steal the generator (6 deaths), the user didn't want the neighbors to know their electricity had been turned off (3 deaths), the user received complaints from property owners or neighbors (2 deaths), the user was attempting to fix a generator (1 death), the user did not realize that generators should be operated outside (3 deaths), the user ran the generator outside, where it would stall, so the user operated it inside for some time and then put it back outside (1 death), and the users brought the generator inside because they wanted the doors locked for security reasons - running it outside would mean that the power cords would have to be run through a slightly open, unlocked door (3 deaths).

**Table 10: Non-Fire Carbon Monoxide Poisoning Deaths
in the Home by Location of the Generator, 1999-2006**

Generator Location	Number of Incidents	Number of Deaths	Percentage of Deaths
Total	200	266	100%
Basement/crawl space	50	67	25%
Garage/enclosed carport/attached barn	57	71	27%
Living space	51	71	27%
Inside house, no further information reported	13	14	5%
Closet	4	11	4%
Doorway	4	6	2%
Outside home	6	6	2%
Shed/detached garage/detached workshop	10	12	5%
Other, under camper	1	1	< 1%
Unknown location, but at home	4	7	3%

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

There was little information available about consumer awareness of the CO hazard associated with generators. Some investigations reported that family, friends, or landlords stated that they had warned the user of the potential CO hazard, but otherwise there was no way to assess whether users were or were not aware of the CO hazard.

Many of the incidents of fatalities in the home (100 of the 266 deaths) did not contain information about the venting of the generator. In 116 of the 166 deaths in which information on venting was available, the generators were not vented at the time of the incident or there was inadequate venting. There were 50 deaths associated with generators that reported that some type of venting was employed. Thirty-five CO deaths were associated with incidents which reported an open window, an open door, an open garage door, or a combination of these. In three deaths, a window or door was open during some period of use but later closed. Nine deaths were associated with generators that were placed outside the home near open windows, doors, or vents. In three deaths, the generator exhaust was directly vented to the outside but the vent leaked.

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 11). 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 (181 investigated deaths), 82 deaths (45%) were associated with a generator in the five-kilowatt rating range. Almost all of the generators 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.

In many of the fatalities (212 of the 334 fatalities), staff could not determine whether the generator was owned by the deceased or a member of the deceased's household, whether it was borrowed, or whether it was rented. In 76 of the deaths, the deceased or a member of the deceased's household owned the generator. In 38 of the deaths, staff determined that the generator was borrowed. In six of the deaths, the generator was rented. And in two cases, it was not clear whether the generators were borrowed or purchased by the victims.

Table 11: Wattage Rating Associated with Generators and a Carbon Monoxide Poisoning Death, 1999-2006

Wattage Rating (in Kilowatts)	Number of Deaths
Total	334
Under 1	2
1-1.9	9
2-2.9	19
3-3.9	38
4-4.9	18
5-5.9	82
6-6.9	9
Greater than 7	4
Not reported	153

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Carboxyhemoglobin (COHb) levels were available for 195 of the 334 fatalities. Table 12 shows the frequency of reports by COHb level categories and age groups. In healthy adults, a COHb level of 40 to 50% 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, seizures, and death; and a level greater than 70% is typically fatal². The majority of fatalities with reported COHb levels (163 of the 195) had levels of 50% or greater COHb.

² Inkster S.E. *Health hazard assessment of CO poisoning associated with emissions from a portable, 5.5 kilowatt, gasoline-powered generator*. Washington, D.C.: U.S. Consumer Product Safety Commission. 2004.

Table 12: Carboxyhemoglobin Levels Associated with Generators and a Non-Fire Carbon Monoxide Poisoning Death by Age Group, 1999-2006

COHb Level	Number of Deaths			
	< 25 years old	25 years or older	Unknown Age	Total Number of Deaths
Total	53	274	7	334
Less than 30%	2	3	0	5
30-39.9%	4	4	0	8
40-49.9%	3	16	0	19
50-59.9%	2	37	0	39
60-69.9%	6	47	0	53
70-79.9%	10	44	1	55
80-89.9%	2	12	0	14
90-99.9%	0	2	0	2
Not Reported	24	109	6	139

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

In-Depth Investigations Associated with a Fatal CO Poisoning and a Tool Included in the ‘Other Engine-Driven Tool’ Category

Forty-three of the 57 deaths associated with other engine-driven tools were investigated further. In the incidents when an investigation was not performed or when difficulties performing the investigation occurred, CPSC staff attempted to gather what information was available from the Injury or Potential Injury Incident (IPII) File and Death Certificate (DTHS) File source documents. Based on CPSC data, all 57 of the incidents investigated involved a single fatality. Two-thirds of the CO fatalities (38 of 57) involved a garden tractor or a power lawn mower. Deaths associated with garden tractors and lawn mowers were often associated with an individual repairing or working on the product in an enclosed space. All but one of the victims in the ‘Other Engine-Driven Tool’ category were males, and all were over 25 years old. More than half of the fatalities (34 out of 57) were between the ages of 45-64. There were ten fatalities of individuals in the 25-44 age group and 13 in the 65-and-over age group. For 37 of the 57 deceased, the carboxyhemoglobin level was provided (Table 13).

Table 13: Carboxyhemoglobin Levels Associated with Other Engine-Driven Tools and a Non-Fire Carbon Monoxide Poisoning Death, 1999-2006

COHb Level	Number of Deaths
Total	57
Less than 30%	0
30-39.9%	2
40-49.9%	6
50-59.9%	8
60-69.9%	6
70-79.9%	9
80-89.9%	6
90-99.9%	0
Not Reported	20

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2007

Conclusion

Between 1999 and 2006, there were 391 CO poisoning deaths reported to CPSC that were associated with engine-driven tools. The majority of these deaths (334) involved generators. Other engine-driven tools, including garden tractors, lawn mowers, power washers or sprayers, and other engine-driven power tools, were associated with a much smaller number of deaths. The majority of fatal incidents reported to CPSC involved a single fatality. Most reported deaths occurred while an individual was at home.

Victims aged 25 years and older accounted for about 82% of CO poisoning deaths reported to CPSC that were associated with generators, and the majority (74%) were male. Seventy-nine percent of the reported deaths associated with generators occurred at home. In about half of the fatalities in the home that involved generators, the generator was placed in the basement or garage of the home. Generators were often used as alternative sources of electricity due to temporary power outages or as power sources for temporary shelters. Weather related outages were the single most common reason for generator usage which resulted in a CO fatality, accounting for at least 103 of the 334 fatalities. Generators were often used with little or no ventilation. Conclusions about why consumers used generators indoors or determinations about whether users were aware of the potential CO poisoning hazard are difficult to make with the available information.

Victims aged 25 years and older accounted for all of the CO poisoning deaths reported to CPSC that were associated with other engine-driven tools. Males accounted for all but one of the 57. Deaths associated with garden tractors and lawn mowers were often associated with an individual repairing or working on the product in an enclosed space.

References

Inkster, S.E. *Health hazard assessment of CO poisoning associated with emissions from a portable, 5.5 kilowatt, gasoline-powered generator.* U.S. Consumer Product Safety Commission. 2004.

Hnatov, M.V. *Non-Fire Carbon Monoxide Fatalities Associated with Engine-Driven Generators and Other Engine-Driven Tools in 2002 through 2005.* U.S. Consumer Product Safety Commission. August 2006.

Marcy, N.E., Ascone, D.S. *Incidents, Deaths, and In-Depth Investigations Associated with Carbon Monoxide and Engine-Driven Tools, 1990-2003.* U.S. Consumer Product Safety Commission. March 2004.

APPENDIX A

The queries below were submitted through EPIR (EPIde miology Retrieval), the CPSC epidemiology data access application. Query results were manually 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: 06/30/2007

Incident dates: 1/1/99 – 12/31/06

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

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

ICD10 Code: X47x, Y17x - (DTHS only)

Narrative/Text contains: 'CARB' or 'MONO'