Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999-2007

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October, 2008

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.

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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 2007 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. This report summarizes the characteristics of non-fire CO poisoning deaths and incidents associated with engine-driven tools that were reported to CPSC staff. This report 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 staff records (as of June 30, 2008), some of the findings of this report are that during the years 1999 through 2007,

- 474 fatalities from 371 fatal incidents were associated with the use of engine-driven tools
- 404 (85%) of these fatalities were associated with generators, 70 (15%) were associated with other engine-driven tools
- Twenty-five percent of generator-related non-fire CO incidents caused multiple fatalities, while all but one of the other engine-driven tool-related incidents (99%) involved a single fatality
- Two-thirds (266 of 404, or 66%) of generator-related fatalities occurred between 2004 and 2007 with more than half (220) occurring between 2005 and 2007
- Nearly half of generator-related non-fire CO fatalities (193 of 404) occurred in the four colder months of the year (November through February)
- Over 80% of the generator-related fatalities occurred in the home
- Eighty-one percent 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 non-fire CO victims were male, while all but two of the other engine-driven tool-related fatalities were male (97%), and
- One-third of all generator-related non-fire CO deaths (134) were associated with power outages. Of these 134 fatalities, 48 (36%) occurred in 2005 – 28 were related to hurricanes or tropical storms and another 18 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).

Note: Throughout this report the year 2007 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 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 report reflects only those incidents reported and entered into CPSC databases on or before June 30, 2008. All non-fire CO incidents found during the database search that were associated with at least one fatality and were determined to be in scope were included.

CPSC staff is aware of 33 non-fire CO fatalities from 26 incidents which were associated with both an engine-driven tool and another product other than an engine-driven tool (such as a gas space heater, water heater, or automobile). These incidents 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.

Summary of Incidents and Deaths Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools

Table 1 shows the number of fatal non-fire carbon monoxide (CO) exposure incidents and the number of deaths in CPSC staff files that occurred between January 1, 1999 and December 31, 2007. 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 371 incidents and 474 deaths due to non-fire CO exposure that occurred between 1999 and 2007 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 non-fire CO incidents which occurred between 1999 and 2007 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 the welder was being used as a welder and, in the other two incidents, the reason for usage could not be ascertained. These three 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 Exposure Incidents and Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-*2007*

Product	Number of Incidents	Number of Deaths
Total Engine-Driven Tools	**371**	**474**
Generators	**302**	**404**
Generator	301	403
Welder (used as a generator)[1]	1	1
Other Engine-Driven Tools	**69**	**70**
Garden tractor or lawn mower	47	47
Power washer/sprayer	6	6
Welder (used as welder or usage unknown)[1]	3	4
Water pump	3	3
Snow blower	3	3
Concrete saw	2	2
Air compressor	2	2
All terrain vehicle	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.
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, 2008

Three hundred two of the 371 incidents reported to CPSC staff were associated with a generator and accounted for 404 of the 474 deaths (85%). Throughout the remainder of this report, 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. About two-thirds of the non-fire, non-generator CO fatalities (47 of 70) 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.

CPSC staff examined the number of deaths associated with each fatal incident (Table 2). Of the 371 fatal incidents, 80% involved a single fatality. Seventy-five percent (228 of 302) 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 69 fatal incidents in the 'Other Engine-Driven Tools' category, only one incident resulted in more than 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-*2007*

Number of Deaths Reported in Incident	Total		Generator		All Other Engine-Driven Tools	
All Incidents	**371**	**100%**	**302**	**100%**	**69**	**100%**
1	296	80%	228	75%	68	99%
2	55	15%	54	18%	1	1%
3	15	4%	15	5%	0	0%
4	3	1%	3	1%	0	0%
5	1	< 1%	1	< 1%	0	0%
6	1	< 1%	1	< 1%	0	0%

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, 2008

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 30, 2008. 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 trend in generator-related non-fire CO fatalities since 1999. The spike in fatalities in 2005, from 46 in 2004 to 94 in 2005, appears to be due primarily to unusually severe weather (this will be discussed in detail on pages 10 and 11 of this report). It is unclear why the 2006 total (83) shown in Table 3 also appears to be elevated since a review of the incidents shows that the number of fatalities associated with weather induced power outages (15) in 2006 is similar to the three years prior to 2005 with 15, 18, and 11 CO deaths for the years 2002 through 2004, respectively, for an average of 14.7 power outage-related CO deaths per year for this time span. The average number of non-fire CO fatalities associated with both generators and other engine-driven tools for years 2003 through 2005 is also presented in Table 3. These three years represent the most recent years for which CPSC staff believes reporting to be substantially

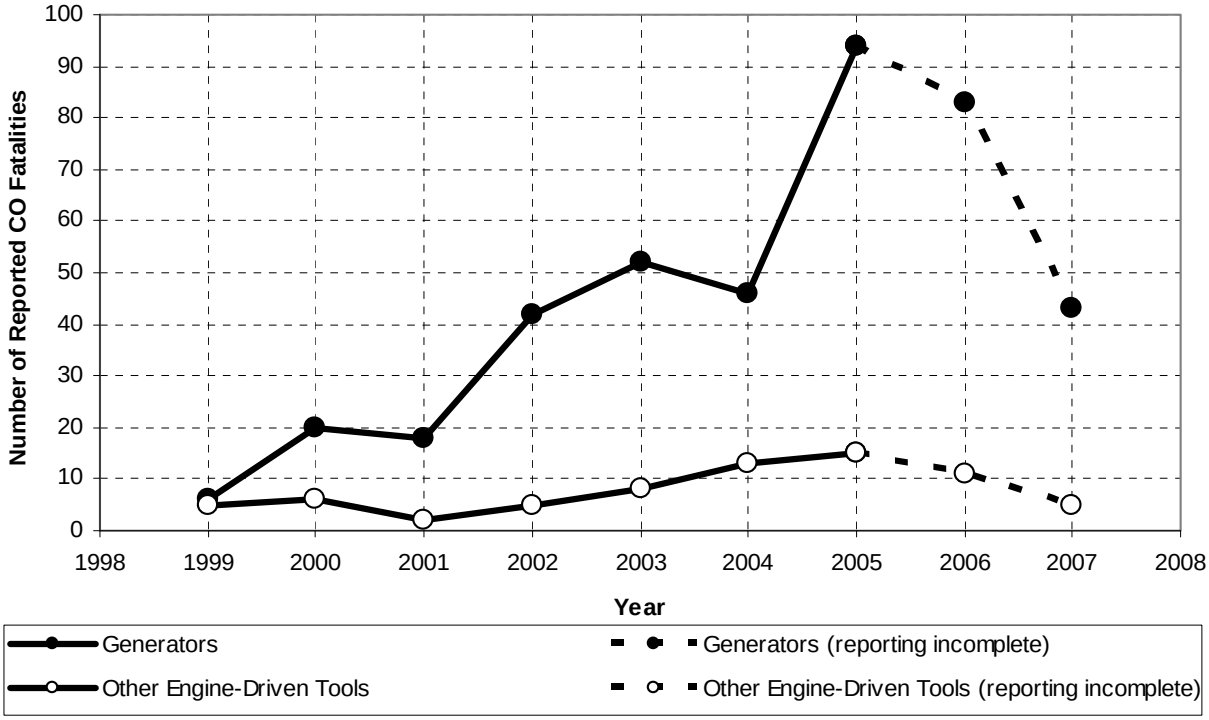
complete. Due to reporting delays, these averages may change in the future when data are complete.

Table 3: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff Associated with Engine-Driven Tools by Year, 1999-*2007*

Year	Total	Generators	All Other Engine-Driven Tools
Total	**474**	**404**	**70**
1999	11	6	5
2000	26	20	6
2001	20	18	2
2002	47	42	5
2003	60	52	8
2004	59	46	13
2005	109	94	15
2006	*94*	*83*	*11*
2007	*48*	*43*	*5*
Average: 2003-2005	76	64	12

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, 2008

Figure 1: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff Associated with Engine-Driven Tools, 1999-*2007*



Staff further examined reported deaths associated with engine-driven tools by the time of year that the incident occurred (Table 4). 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.

Table 4: Number of Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Season, 1999-*2007*

Season Incident Occurred	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	**474**	**100%**	**404**	**100%**	**70**	**100%**
Cold months	220	46%	193	48%	27	39%
Warm months	104	22%	84	21%	20	29%
Transitional months	150	32%	127	31%	23	33%

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, 2008

Forty-six percent of the non-fire CO deaths associated with an engine-driven tool occurred in the colder months of November through February. Many of the fatalities can be directly associated with the use of generators during power outages due to weather conditions such as ice or snow storms. Thirty-one 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 will be presented later in the analysis of reasons for generator usage during the fatal incidents in the *Additional Generator-Specific Fatal Non-Fire CO Poisoning Findings* section starting on page 10.

Incidents involving deaths are further summarized in Table 5 by the location where the death occurred. The majority of non-fire CO poisoning deaths (83%) 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 incidents in which victims died from CO poisoning from portable generators or other engine-driven tools which were brought into trailers, horse trailers, recreational vehicles (RVs), vans, cabins, tents, and campers. Incidents that occurred in a temporary shelter where the generator was an integral part of the temporary shelter, such as a built-in or purpose-built generator in an RV, were determined to be out of scope for this report and were excluded. 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. As with temporary shelters, 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. 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-*2007*

Location	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	**474**	**100%**	**404**	**100%**	**70**	**100%**
Home	392	83%	327	81%	65	93%
Temporary shelter	59	12%	58	14%	1	1%
Boat	5	1%	5	1%	0	0%
Other	12	3%	9	2%	3	4%
Not reported	6	1%	5	1%	1	1%

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, 2008

Tables 6 and 7 present the distribution of age and gender of the victims, respectively. Table 6 shows that victims aged 25 years and older accounted for about 84% (398 of 474) of reported non-fire CO poisoning deaths associated with all engine-driven tools. Victims aged 25 years and older accounted for about 81% (328 of 404) of non-fire CO poisoning deaths associated with generators and accounted for all deaths associated with other engine-driven tools. More than half of the non-fire CO fatalities associated with non-generator engine-driven tools (39 of 70) were between the ages of 45-64. Male victims accounted for 77% 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 7).

Table 6: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Age of Victim, 1999-*2007*

Age	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	**474**	**100%**	**404**	**100%**	**70**	**100%**
Under 5	10	2%	10	2%	0	0%
5 – 14	19	4%	19	5%	0	0%
15 – 24	39	8%	39	10%	0	0%
25 – 44	144	30%	132	33%	12	17%
45 – 64	171	36%	132	33%	39	56%
65 and over	83	18%	64	16%	19	27%
Unknown	8	2%	8	2%	0	0%

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, 2008

Table 7: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Engine-Driven Tools by Gender of Victim, 1999-*2007*

Gender	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	**474**	**100%**	**404**	**100%**	**70**	**100%**
Male	366	77%	298	74%	68	97%
Female	108	23%	106	26%	2	3%

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, 2008

Carboxyhemoglobin (COHb) levels were available for 269 of the 474 fatalities. Table 8 shows the frequency of reports by COHb level categories. 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, seizure, and death; and a level greater than 70% is typically fatal[1]. The majority of fatalities with reported COHb levels (218 of the 269) had levels of 50% or greater.

Table 8: Carboxyhemoglobin Levels Associated with Engine-Driven Tools Non-Fire Carbon Monoxide Poisoning Deaths, 1999-*2007*

COHb Level	Number of Deaths					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
Total	**474**	**100%**	**404**	**100%**	**70**	**100%**
Less than 30%	7	1%	7	2%	0	0%
30-39.9%	14	3%	11	3%	3	4%
40-49.9%	30	6%	23	7%	7	10%
50-59.9%	51	11%	44	11%	7	10%
60-69.9%	69	15%	60	15%	9	13%
70-79.9%	70	15%	59	15%	11	16%
80-89.9%	25	5%	16	4%	9	13%
90-99.9%	3	1%	3	1%	0	0%
Not reported	205	43%	181	45%	24	34%

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, 2008

[1] 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.

Additional Generator-Specific Fatal Non-Fire CO Poisoning Findings

CPSC staff conducted 371 In-depth Investigations (IDIs) related to non-fire CO incidents associated with engine-driven tools. Investigators were not always able to gather all of the requested data for various reasons. Investigators may not be able to obtain a response or documentation from law enforcement, fire department and emergency room personnel. Or, state laws may restrict investigators access to important documentation or to contact victims or victim's next of kin. In cases where the investigations did not provide all of the requested information or the incident was not investigated, attempts were made to augment the data from the Injury and Potential Injury Incidents (IPII) records or from death certificate information.

A review of records for the 404 generator-related non-fire CO deaths reported to CPSC staff 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 9 provides a breakdown of the reasons why a generator was in use at the time of the incident. One-third of the 404 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. Nearly one-fifth (19%) of the fatalities were associated with the use of generators after power was shut off to the residence by the utility company. In 55 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 9: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators by Reason for Use, 1999-*2007*

Reason for Use	Number of Deaths	Percentage
Total	**404**	**100%**
Power outage due to weather or problem with power distribution	134	33%
Electricity turned off by power company due to bill dispute or nonpayment	75	19%
Provide power to storage shed, trailer, boat, camper, cabin, campsite	67	17%
New home or homeowner and power not yet turned on, home under construction or renovation	36	9%
Provide power to home or mobile home which normally does not have electricity	24	6%
Working on or preparing a home for predicted storm	3	1%
Other (previous fire in house, power shut off by owners, servicing power supply)	10	2%
Unknown why electricity off	55	14%

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, 2008

For the 134 fatalities associated with a power outage due to weather or a problem with power distribution, Table 10 provides a breakdown by year and cause of the power outage. More than

90% (121 of 134) of the fatalities were associated with a specific weather condition which caused the power outage. The 48 power outage-related fatalities in 2005 was unusually 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 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 18 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 nine-year period covered by this report, 36% (48 of 134) of the power outage-related non-fire CO fatalities occurred in 2005. Figure 2 illustrates the impact of the power outages in 2005 relative to other years.

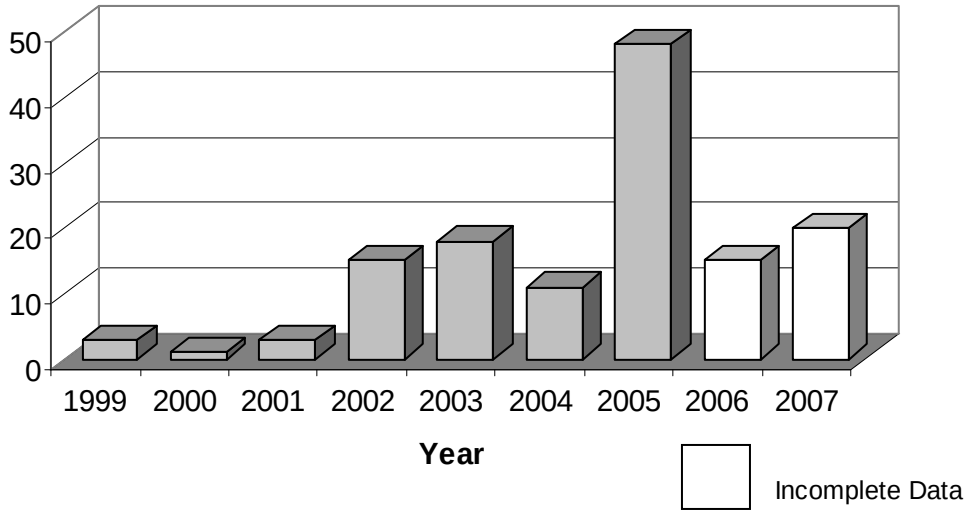
Table 10: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC Staff and Associated with Generators by Reason for Power Outage, 1999-*2007*

Generator Location	Total	1999	2000	2001	2002	2003	2004	2005	*2006*	*2007*
Total	**134**	**3**	**1**	**3**	**15**	**18**	**11**	**48**	***15***	***20***
Ice or snow storm	56	0	0	0	13	7	2	18	*7*	*9*
Hurricane or tropical storm	47	0	0	0	1	8	9	28	*1*	*0*
Thunderstorm	6	0	0	1	0	2	0	1	*2*	*0*
Wind storm	9	0	0	1	0	0	0	0	*5*	*3*
Storm, unspecified	3	0	0	0	0	0	0	0	*0*	*3*
Unknown reason for outage	13	3	1	1	1	1	0	1	*0*	*5*

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, 2008

For the 404 generator-related non-fire CO fatalities, information was available for 351 deaths (87%) on the victim's location in relation to the generator. One hundred and seven of these 351 fatalities (30%) occurred in the same room or space as the generator, and 244 of the victims (70%) were found in rooms or spaces apart from the generator. Of the 404 generator-related fatalities, there were 53 deaths (13%) in which it could not be determined where the victim was in relation to the generator.

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



Information regarding the 327 non-fire CO deaths that occurred in a home was further classified by the specific location of the generator (Table 11). 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.

Table 11: Non-Fire Carbon Monoxide Poisoning Deaths in the Home by Location of the Generator, 1999-*2007*

Generator Location	Number of Incidents	Number of Deaths	Percentage of Deaths
Total	**251**	**327**	**100%**
Living space	68	92	28%
Garage/enclosed carport/attached barn	70	88	27%
Basement/crawl space	59	79	24%
Inside house, no further information reported	16	17	5%
Shed/detached garage/detached workshop	14	16	5%
Closet	4	11	3%
Outside home	8	8	2%
Doorway	4	6	2%
Other, under camper	1	1	< 1%
Unknown location, but at home	7	9	3%

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, 2008

Table 12 presents a summary of non-fire CO fatalities occurring in the home characterized by venting status. Many of the incidents of generator associated fatalities in the home (132 of the 327 deaths) did not contain information about the venting of the generator. In 126 of the 195 deaths (65%) in which information on venting of the generator was available, the generators were not vented at the time of the incident. There were 69 deaths associated with generators that reported that some type of venting was employed. Forty-eight non-fire 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. Twelve deaths were associated with generators that were placed outside the home near open windows, doors, or vents. In nine deaths, the generator exhaust was directly vented to the 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. And in one death, the generator was placed outside of an apartment in a hallway.

Table 12: Non-Fire CO Fatalities Associated with Generators Categorized by Status of Venting, 1999-*2007*

Venting Status	Number of Deaths
Non-fire CO fatalities in the home	**327**
Some venting attempted	**69**
Open window(s), open door(s), an open garage door, or a combination of these	48
Actively trying to vent either by fans or by directing exhaust out a window or door	9
Placed outside, but near a window, door or A/C unit	12
No venting	**126**
Open windows or doors closed sometime later	3
No venting attempted	123*
Unknown venting	**132**

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2008
Note: Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.
* One death occurred when a generator was placed outside an apartment in an unvented hallway.

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 13). 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 (210 investigated deaths), 89 deaths (42%) 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.

Table 13: Non-Fire CO Fatalities Associated with Generators Categorized by Generator Wattage Rating, 1999-*2007*

Wattage Rating (in Kilowatts)	Number of Deaths
Total	**404**
Under 1	2
1-1.9	16
2-2.9	19
3-3.9	43
4-4.9	23
5-5.9	89
6-6.9	12
Greater than 7	6
Not reported	194

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2008
Note: Italicized numbers indicate that reporting of incidents is ongoing. Counts may change in subsequent reports.

In many of the fatalities (233 of the 404 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 106 of the deaths, the deceased or a member of the deceased's household owned the generator. In 56 of the deaths, staff determined that the generator was borrowed. And in nine of the deaths, the generator was rented.

Conclusion

Between 1999 and 2007, there were 474 non-fire CO poisoning deaths reported to CPSC staff that were associated with engine-driven tools. The majority of these deaths (404) involved generators. 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-one 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 non-fire CO fatality, accounting for at least 134 of the 404 fatalities (33%). 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 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 two of the 70 deaths. 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. *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999-2006*. U.S. Consumer Product Safety Commission. October 2007.

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 (EPIdemiology Retrieval), the CPSC staff's 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: 06/30/2008

Incident Dates: 1/1/99-12/31/07
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'