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Memorandum

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SUBJECT : Incidents, Deaths, and In-Depth Investigations Associated with Carbon  
Monoxide from Engine-Driven Generators and Other Engine-Driven  
Tools, 1990-2004

This memorandum summarizes carbon monoxide (CO) incidents from the Consumer Product Safety Commission (CPSC) databases that were associated with engine-driven generators and other engine-driven tools that occurred between 1990 and 2004.<sup>1</sup> Other engine-driven tools include tools such as power lawn mowers, garden tractors, portable pumps, power sprayers and washers, snow blowers, and floor buffers. This memorandum summarizes the characteristics of CO poisoning deaths and investigated incidents reported to CPSC associated with engine-driven tools. This memorandum also provides a more detailed summary of fatal CO poisoning incidents associated with engine-driven tools found in CPSC's In-depth Investigation (INDP) File.

The following CPSC databases were searched: 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. It should be noted that reporting may not be complete, and this memorandum reflects only those incidents entered into CPSC databases before June 27, 2005. All CO incidents found during the database search that were associated with at least one CO fatality or a non-fatal exposure to CO that resulted in one or more individuals attending a medical facility for treatment were included. Appendix B provides a listing of the incidents referenced in this memorandum.

Twenty-two incidents associated with both an engine-driven tool and a non-engine driven tool source of CO (such as a gas space heater or water heater) were considered out of scope for this

<sup>1</sup> 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.

memo, since the exact source of the CO could not be determined.<sup>2</sup> Incidents associated with multiple engine-driven tools (such as a generator and a lawn mower) were included. Incidents associated with generators that were specifically reported as integral parts of recreational vehicles (RVs), motor homes, or boats 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 was not specifically stated were excluded from the analysis. For one fatal incident in a boat and two separate fatal incidents in a motor home, CPSC staff could not specifically conclude that the generator was an integral part of the boat or motor home. In addition, a non-fatal incident in a camper and a non-fatal incident in a boat were associated with generators where it could not be specifically determined if the generator was an integral part.<sup>3</sup> Therefore these five incidents were excluded. Also, one incident that was determined to be work-related was not included.<sup>4</sup>

**Table 1: Number of Non-fire Carbon Monoxide Potential Exposure Incidents and Deaths Reported to CPSC Associated with Engine-Driven Tools, 1990-2004**

Product	Number of Incidents	Number of Deaths
<b>Total</b>	<b>317</b>	<b>318</b>
Generator	263	274
Garden tractor and lawn mower	35	33
Snow blower	5	5
Floor buffer	3	0
Pumps	3	2
Power washer and sprayer	4	1
Other engine-driven power tools or internal combustion engine (non-vehicular)	3	2
Multiple engine-driven tools	1	1

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

Table 1 shows the number of carbon monoxide exposure incidents and deaths in CPSC files associated with generators and other engine-driven tools that occurred between January 1, 1990 and December 31, 2004. Staff found in CPSC’s files 317 incidents and 318 deaths that occurred between 1990 and 2004 inclusive involving engine-driven tools and a potential CO exposure. The term *potential* is used to characterize these incidents because the CO exposure could not be confirmed for some of the non-fatal incidents. Incidents were associated with portable generators, garden tractors, lawn mowers, snow blowers, floor buffers, portable pumps, power washers and sprayers, other engine-driven power tools, and multiple engine-driven tools. The category ‘other engine-driven power tools’ includes gas floor and concrete cutters. The category

<sup>2</sup> 0021038891, 0156001192, 0227037489, 0302000494, 030219HEP9015, 9845030920, 9926010886, B9529423A, G9130305A, N0120209A, X0231359A, X0310578A, X0331336A, X9122456A, X9176126A, X9621373A, 0134003962, 0218009073, 0218008207, 0355044625, 0451005498, and X0452231A.

<sup>3</sup> These incidents were excluded from the analysis: X99B3684B and 010301HEP9009 (non-fatal incidents); and 9522020180, G9160205A, and N9470214A (fatal incidents). In all five of these incidents, the integral nature of the involved generator was unknown. These incidents were included in analyses in previous memoranda.

<sup>4</sup> This incident was excluded: 050223HCC1506.

‘multiple engine-driven tools’ includes an incident that involved both a generator and a power lawn mower.

Two hundred and sixty-three of the 317 incidents reported to CPSC were associated with generators. Two hundred seventy-four (86%) of the deaths were associated with generators. Throughout the remainder of this memo, incidents associated with all 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 occurring during each incident (Table 2). Twenty-two percent of the CO exposure incidents reported to CPSC and associated with an engine-driven tool were not associated with a CO poisoning fatality. Of those incidents that did involve at least one death (246 incidents), 77% involved a single fatality. Seventy-three percent of fatal generator incidents involved a single fatality. Of the 43 fatal incidents in the ‘all other engine-driven tools’ category, all but one incident were associated with a single fatality. The one multiple CO fatality incident in this category involved a sump pump.

**Table 2: Number of Carbon Monoxide Poisoning Incidents Reported to CPSC by Number of Deaths per Incident, 1990-2004**

<b>Number of Deaths Reported in Incident</b>	<b>Total</b>		<b>Generator</b>		<b>All Other Engine-Driven Tools</b>	
<b>Total Incidents</b>	<b>317</b>	<b>(100)</b>	<b>263</b>	<b>(100)</b>	<b>54</b>	<b>(100)</b>
0	71	(22)	60	(23)	11	(20)
1	190	(60)	148	(56)	42	(78)
2	45	(14)	44	(17)	1	(2)
3	6	(2)	6	(2)	0	(0)
4	5	(2)	5	(2)	0	(0)

Note: Numbers in parentheses represent percentages. Totals may not add to 100% due to rounding.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

Due to the difficulties in defining a CO poisoning injury or confirming a CO exposure, the remainder of this memorandum will focus only on CO poisoning incidents that involved a death associated with an engine-driven tool. Throughout this memorandum, the number of deaths represents the actual number of deaths that have been entered in the CPSC databases by June 27, 2005. The count is the unweighted, actual number of CO poisoning deaths in the CPSC files associated with generators and other engine-driven tools.

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 figures in Table 3 represent the numbers of deaths reported to CPSC as of June 27, 2005. Some deaths are reported to CPSC shortly after an incident occurs, while other deaths are reported to CPSC months or years after an incident occurs. Therefore, counts for more recent years may not be as complete as counts for earlier years. It should also be noted that death certificates for years 1999 and later were coded under the Tenth Revision of the International Classification of Diseases (ICD-10). With the transition to ICD-10 in 1999, the types of death certificates purchased by CPSC changed. These changes could affect the numbers of deaths associated with engine-driven tools that are reported to CPSC. Prior to 1999, these deaths were normally coded with an ICD-9 e-code (868.2) for motor vehicle

exhaust deaths. These death certificates were not routinely purchased by CPSC. Occasionally, some death certificates that were related to the products in this memo were reported to CPSC under other e-codes, (usually under e-codes 868.8 [carbon monoxide from other sources] and 868.9 [unspecified carbon monoxide]). In January of 1999, CPSC began purchasing death certificates classified in ICD-10 codes that contain all unintentional CO poisoning deaths associated with all sources of carbon monoxide, including motor vehicles.

**Table 3: Number of Non-fire Carbon Monoxide Poisoning Deaths Reported to CPSC Associated with Engine-Driven Tools By Year, 1990-2004**

Year	Total	Generators	All Other Engine-Driven Tools
<b>Total</b>	<b>318</b>	<b>274</b>	<b>44</b>
1990	18	18	0
1991	4	3	1
1992	7	7	0
1993	14	11	3
1994 <sup>+</sup>	8	5	3
1995 <sup>+</sup>	11	10	1
1996	20	17	3
1997	20	18	2
1998	14	13	1
1999 <sup>*</sup>	11	6	5
2000	26	20	6
2001	21	18	3
2002	47	42	5
2003	57	51	6
2004	40	35	5

\* The ICD-10 system was implemented in 1999

+ The number of deaths associated with engine-driven products in 1994 and 1995 differ from those reported in the annual estimate report.<sup>5,6</sup> This is due to the exclusion of products that were integral parts of boats in this report.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

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). About 39 percent of the deaths associated with an engine-driven tool occurred in the winter.

<sup>5</sup> Ault K. "Estimates of Non-fire Carbon Monoxide Poisoning Deaths and Injuries," Washington, D.C.: U.S. Consumer Product Safety Commission. 1997.

<sup>6</sup> Mah J. "Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products, 1998 Annual Estimates." Washington, D.C.: U.S. Consumer Product Safety Commission. 2001.

**Table 4: Number of Non-fire Carbon Monoxide Poisoning Deaths Reported to CPSC and Associated with Engine-Driven Tools by Season, 1990-2004**

Season Incident Occurred	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
<b>Total</b>	<b>318</b>	<b>(100)</b>	<b>274</b>	<b>(100)</b>	<b>44</b>	<b>(100)</b>
Winter	124	(39)	108	(39)	16	(36)
Spring	50	(16)	39	(14)	11	(25)
Summer	65	(20)	56	(20)	9	(20)
Fall	79	(25)	71	(26)	8	(18)

Note: Numbers in parentheses represent percentages. Totals may not add to 100% due to rounding.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

There were 12 reported incidents relating to the 2004 hurricane season that involved a CO poisoning death or injury that received medical treatment. There were eight hurricane-related deaths reported, five of which occurred in Florida.<sup>7</sup> There were 29 reported injuries that resulted in medical treatment.

Incidents involving deaths were further examined in Table 5 by the location where the death occurred. The majority of CO poisoning deaths (77%) reported to CPSC and associated with engine-driven tools occurred at a home, which included single-family homes, apartments, and mobile homes. The home location also includes garages or sheds at homes or residences. The temporary shelter category includes trailers, horse trailers, motor homes, recreational vehicles, vans, cabins, and campers. The ‘other’ category includes incidents occurring in some of the following locations: bar, building, church, greenhouse, mineshaft, public place, and storage shed (offsite from home).

**Table 5: Number of Non-fire Carbon Monoxide Poisoning Deaths Reported to CPSC and Associated with Engine-Driven Tools by Location, 1990-2004**

Location	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
<b>Total</b>	<b>318</b>	<b>(100)</b>	<b>274</b>	<b>(100)</b>	<b>44</b>	<b>(100)</b>
Home	246	(77)	204	(74)	42	(95)
Temporary shelter	40	(13)	40	(15)	0	(0)
Boat	7	(2)	7	(3)	0	(0)
Other	12	(4)	12	(4)	0	(0)
Not reported	13	(4)	11	(4)	2	(5)

Note: Numbers in parentheses represent percentages. Totals may not add to 100% due to rounding.

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

<sup>7</sup> There was one case, 050223HCC1506, that was not included in this count because the incident was work-related. It was, however, included in the count of cases reported in the MMWR article entitled [Carbon Monoxide Poisonings from Hurricane-Associated Use of Portable Generators – Florida, 2004](#), July 22, 2005.

Tables 6 and 7 present the distribution of age and sex of the deceased in the incidents. Table 6 shows that adults aged 25 years and older accounted for about 83% of reported CO poisoning deaths associated with all engine-driven tools. Adults age 25 years and older accounted for about 81% of CO poisoning deaths associated with generators and accounted for all deaths associated with other engine-driven tools. Males accounted for 75% of the deaths associated with all engine-driven tools and 71% of the deaths associated with generators. One female death was associated with a sump pump, and another female death was associated with a lawn mower in a different incident; both of these deaths were categorized as ‘all other engine-driven tools’.

**Table 6: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC and Associated with Engine-Driven Tools by Age of Victim, 1990-2004**

Age	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
<b>Total</b>	<b>318</b>	<b>(100)</b>	<b>274</b>	<b>(100)</b>	<b>44</b>	<b>(100)</b>
Under 5	8	(3)	8	(3)	0	(0)
5 – 14	20	(6)	20	(7)	0	(0)
15 – 24	19	(6)	19	(7)	0	(0)
25 – 44	99	(31)	90	(33)	9	(21)
45 – 64	105	(33)	83	(30)	22	(50)
65 and over	61	(19)	48	(18)	13	(30)
Unknown	6	(2)	6	(2)	0	(0)

Note: Numbers in parentheses represent percentages. Totals may not add to 100% due to rounding.  
Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

**Table 7: Non-Fire Carbon Monoxide Poisoning Deaths Reported to CPSC and Associated with Engine-Driven Tools by Sex of Victim, 1990-2004**

Sex	Number of Deaths Reported to CPSC					
	All Engine-Driven Tools		Generators		All Other Engine-Driven Tools	
<b>Total</b>	<b>318</b>	<b>(100)</b>	<b>274</b>	<b>(100)</b>	<b>44</b>	<b>(100)</b>
Male	237	(75)	195	(71)	42	(95)
Female	81	(25)	79	(29)	2	(5)

Note: Numbers in parentheses represent percentages. Totals may not add to 100% due to rounding.  
Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

### **In-Depth Investigations of Engine-Driven Tool Incidents**

Data from CPSC’s In-depth Investigation File are not a statistical sample and national totals may not be derived from the number of incidents investigated. Data provide examples of actual incidents and anecdotal information. Incidents 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. Not all information examined is available for each investigation.

CPSC staff further investigated 216 of the 317 incidents referenced in this memorandum. In-depth investigations associated with engine-driven tools have been requested more frequently in recent years. For example, 94% of the incidents associated with engine-driven tools that were reported to CPSC were investigated in 2004, and only 10% of the incidents were investigated in 1990. Of the 216 in-depth investigations investigated, 164 involved at least one fatality. These 164 in-depth investigations of fatal incidents involved 216 deaths. One hundred and eighty-nine of these deaths were associated with generators and 27 deaths were associated with other engine-driven tools.

Pre-existing health conditions affecting the heart, lungs, liver, and circulatory system can increase an individual's susceptibility to elevated carboxyhemoglobin (COHb) levels in the bloodstream, increasing the risk of a fatal CO exposure. Although this information was not available for all investigated deaths, 22 of the 216 CO deaths investigated that were associated with engine-driven tools involved individuals who had pre-existing health conditions not related to CO poisoning at the time of death.

Alcohol and drug use can act as a central nervous system depressant causing dulled reactions, which could likely impair a person's ability to react appropriately to a CO hazard, thus potentially prolonging exposure and increasing the chance of a fatal outcome. Although this information was not available for all investigated deaths, 39 of the 216 deaths investigated noted that the victim had used alcohol or recreational drugs during the time period surrounding the incident.

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

CPSC staff further explored the 189 fatalities, which involved 137 in-depth investigations of fatal generator incidents. The characteristics of age and sex of victim, location of death, and number of fatalities per incident were similar in the total group of reported deaths associated with generators to those that were further investigated. About 82% of the deaths reported to CPSC involved adults aged 25 years and older, and about 80% of the deaths investigated involved adults 25 years and older. Males accounted for 71% of the reported CO deaths associated with generators and 67% of deaths investigated. The location of the death was also similar for those cases that were investigated versus all CO poisoning deaths reported. The majority of deaths investigated (77%) occurred in a home, while 73% of deaths reported occurred in a home. Fifteen percent of the deaths investigated occurred in a temporary shelter, while 16% of the total reported deaths occurred in a temporary shelter. Incidents investigated that involved at least one death were similar to reported generator incidents that involved at least one death in that 77% of all the fatal incidents reported involved a single fatality, while 70% of the investigated deaths involved a single fatality.

Information provided in investigations 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 the CO at the location where the generator was used, and the carboxyhemoglobin (COHb) levels of the deceased.

The 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. Sixty investigated deaths involved generators used during a temporary power outage stemming from a weather problem or a problem with power distribution; 39 investigated deaths involved generators used to supply power to a temporary shelter, storage-shed (offsite from the home), or boat that did not have electricity; 23 investigated deaths involved generators used in a situation where the utility company, often because of an overdue payment, turned off the power; 26 investigated deaths were associated with locations where the electricity was off due to another reason, such as recent fire at the location, the home was abandoned, the home was a new home that did not have electricity at the time of the incident, the residents of the home requested that the electricity be turned off, or a home was undergoing a remodeling project. Twenty-five of the deaths investigated involved incidents where the electricity was off at the location but the reason why was unknown. Fourteen of the deaths investigated involved a generator used in a more permanent situation, such as to supply power to a home or mobile home that did not normally have electricity or to provide power to a garage of a home. Two deaths were associated with incidents where the user was repairing a generator or was preparing the generator for use due to forecasted bad weather.

**Table 8: In-Depth Investigations Associated with Generators and Carbon Monoxide Poisoning Deaths in the Home by Location of the Generator, 1990-2004**

<b>Generator Location</b>	<b>Number of Deaths</b>
<b>Total</b>	<b>146</b>
Basement/crawl space	48
Garage/enclosed carport	41
Living space	33
Inside house, no further information reported	8
Closet	3
Doorway	2
Outside home	7
Shed	2
Other, inside a nearby mobile home	1
Unknown location, but at home	1

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

In-depth investigations of CO deaths that occurred in a home were further classified by the specific location of the generator (Table 8). 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. Although this information was not available for all incidents, 30 of the deceased individuals were found in the same room or space of the home as the generator, and 105 of the deceased individuals were found in different rooms or spaces of the home. In some cases, individuals were found in rooms



located above the basement or in rooms next to or above the garage where the generator was located.

Conclusions about a consumer's reasons for placing a generator indoors, along with determinations of the consumer's awareness of the carbon monoxide hazard associated with the use of a generator in an enclosed space, are difficult to make from information obtained in the typical investigation. The reason a generator was operated in a certain location was provided in the investigations for only 32 deaths. The most common reason mentioned for using the generator indoors was that the user feared that someone might steal the generator (11 deaths). Other reasons for using the generator indoors included: to muffle the sound (6 deaths), the users didn't want the neighbors to know their electricity had been turned off (3 deaths), complaints of property owners or neighbors (2 deaths), a user attempting to fix a generator (1 death), users not realizing their generators should be operated outside (5 deaths), a case in which 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 cases in which an attempt was made to directly vent the generator exhaust to the outside (3 deaths).

There was little information available in the investigations about whether users were aware of the CO hazard associated with using generators indoors. Some investigations reported that family, friends, or landlords stated that they had forewarned 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 issue.

Many of the death investigations (85 of the 189 deaths investigated) did not contain information about the exact venting of the generator. In 63 of the 104 deaths investigated in which information on the venting was available, the generators were not vented at the time of the incident. In one investigated death where there was no venting, the room with the generator was thought to be sealed off from the rest of the house. There were 40 investigations that reported that some type of venting was employed. Twenty-four investigated deaths reported an open window, an open door, an open garage door, or a combination of these. In five investigated deaths, a window or door was open during some period of use but later closed. Five investigated deaths were associated with a generator that was placed outside the home near an open window, door, or vent. Two investigated deaths were associated with a portable generator used on a boat; the users attempted to vent the generator by modifying the exhaust system in place for an installed generator. In one investigated death the associated generator was operated outdoors for some time. It would stall and would then be operated in the doorway for a period of time. In three investigated 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 9). 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. For 32 incidents in which the in-depth investigation provided the make, model, and/or engine size of the associated generator but not the wattage rating, CPSC staff used the identifying information to ascertain the power rating. When the wattage rating of the generator was known or could be determined (108 investigated deaths), 53 investigated deaths were associated with a generator in the five-kilowatt rating range. Almost all of the generators

were referred to as gas or gasoline generators. One generator was identified as a propane generator and one was identified as a natural gas generator.

**Table 9: Wattage Rating Reported in In-Depth Investigations Associated with Generators and a Carbon Monoxide Poisoning Death, 1990-2004**

Wattage Rating (in Kilowatts)	Number of Deaths
<b>Total</b>	<b>189</b>
Under 1	3
1-1.9	7
2-2.9	8
3-3.9	20
4-4.9	8
5-5.9	53
6-6.9	8
Greater than 7	1
Not reported	81

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

In many of the investigations (109 of the 189 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 the investigations of 41 of the deaths, the deceased or a member of the deceased’s household owned the generator. In investigations of 33 of the deaths, staff determined that the generator was borrowed. In investigations of six of the deaths, the generator was rented.

**Table 10: Carboxyhemoglobin Levels Reported in In-Depth Investigations Associated with Generators and a Carbon Monoxide Poisoning Death, 1990-2004**

COHb Level	Number of Deaths
<b>Total</b>	<b>189</b>
Less than 30%	2
30-39.9%	4
40-49.9%	12
50-59.9%	14
60-69.9%	38
70-79.9%	29
80-89.9%	10
90-99.9%	1
Not Reported	79

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

Carboxyhemoglobin (COHb) levels were provided in the investigations for 110 of the 189 fatalities. Table 10 provides a breakdown of the COHb levels. In healthy adults, a COHb level of 40 to 50% approximately correlates with symptoms of ‘confusion, unconsciousness, coma, possible death’ ; a level of 50 to 70% approximately correlates with symptoms of ‘coma, brain

damage, seizures, death’ ; and a level greater than 70% is ‘typically fatal’.<sup>8</sup> The majority of individuals with reported COHb levels (92 of the 110) had levels greater than 50% COHb.

Twenty-seven investigations (associated with 36 deaths) provided ambient levels of carbon monoxide at the location, measured as parts per million (ppm). Some values were measured only after the location had been vented and/or the generator had been shut down, often because the generator had run out of fuel, for some time prior to the measurement. The six investigations that did not have maximum CO levels greater than 150 ppm reported that the location had been vented prior to the measurement of the CO level, or the measurement of the CO level took place hours after the incident. Twenty-one of the investigations had maximum CO levels that measured greater than 150 ppm: six investigations had CO levels between 150 and 299 ppm, two investigations had levels between 300 and 449 ppm, three investigations had levels between 450 and 599 ppm, and ten investigations had levels higher than 600 ppm.

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

Twenty-seven of the 44 deaths associated with other engine-driven tools were investigated further. All 27 of the incidents investigated involved a single fatality. Twenty-six of the investigated deaths involved a garden tractor or a power lawn mower, although one investigation involved both a generator and a power lawn mower. One investigated incident involved a gas concrete cutter. All the deceased in these investigations were males and roughly half of the investigations (14 out of 27) involved individuals between the ages of 45-64. Five fatal investigations involved deaths of individuals in the 25-44 age group and eight fatal investigations involved deaths of individuals in the 65-and-over age group.

**Table 11: Carboxyhemoglobin Levels Reported in In-Depth Investigations Associated with Other Engine-driven Tools and a Carbon Monoxide Poisoning Death, 1990-2004**

COHb Level	Number of Deaths
<b>Total</b>	<b>27</b>
30-39.9%	1
40-49.9%	3
50-59.9%	5
60-69.9%	6
70-79.9%	6
80-89.9%	4
Unknown Level	2

Source: U. S. Consumer Product Safety Commission, Directorate for Epidemiology, 2005

For 25 of the 27 deceased, the carboxyhemoglobin level was provided (Table 11). Ambient CO levels were provided in only four of the investigations. One investigation reported an ambient CO level of 20 ppm in the garage and a maximum of 80 ppm in the house. These measurements were taken after venting. One investigation reported a maximum ambient CO level of 740 ppm

<sup>8</sup> Burton LE. Toxicity from Low Level Human Exposure to Carbon Monoxide. Washington, D.C.: U.S. Consumer Product Safety Commission. 1996.

with the doors open. For the two other incidents reported, ambient CO levels of 101 ppm and 76.9 ppm were recorded when the police or fire department responded to the scene after the deceased had been discovered.

All 26 of the investigated deaths associated with a lawn mower or garden tractor occurred in an enclosed space at a home, with 14 investigated deaths occurring in the garage of a home, 11 in the shed of a home, and one in a utility building. Twenty-two of these investigations provided details as to why the lawn mower or garden tractor was being used within an enclosed space. The majority of these investigated deaths (17 out of 22) involved the victim working on or repairing a garden tractor or power lawn mower within an enclosed space. The one death associated with the concrete cutter occurred in the basement of a home.

## **Conclusion**

Between 1990 and 2004 there were 318 CO poisoning deaths reported to CPSC that were associated with engine-driven tools. The majority of these deaths (274) involved generators. Other engine-driven tools that were associated with a much smaller number of deaths included garden tractors, lawn mowers, snow blowers, pumps, power washers or sprayers, and other engine-driven power tools. The majority of fatal incidents reported to CPSC involved a single fatality. Most reported deaths occurred while an individual was at home.

Adults aged 25 years and older accounted for about 81% of CO poisoning deaths reported to CPSC associated with generators, and the majority (71%) was male. Seventy-four percent of the reported deaths associated with generators occurred at home. Generators were commonly 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. 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 hazards are difficult to make with the available information.

Adults aged 25 years and older accounted for all of the CO poisoning deaths reported to CPSC associated with engine-driven tools, excluding generators. Males accounted for all but two of the 44 deaths reported to CPSC 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.

## References

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Carlson S. Incidents, Deaths, and In-Depth Investigations Associated with Carbon Monoxide and Engine-Driven Tools, 1990-2003, memorandum. March 8, 2004. U.S. Consumer Product Safety Commission.

Mah J. *Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products, 1998 Annual Estimates*. U.S. Consumer Product Safety Commission. 2001.

Marcy NE, Ascone DS. *Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products, 2002 Annual Estimates*. U.S. Consumer Product Safety Commission. July 2005.

## **APPENDIX A**

The queries below were submitted through the EPIR application. Query results were manually reviewed to include only carbon monoxide poisoning hazards 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. Work-related cases were also excluded.

Date of Queries: 06/27/2004

Incident dates: 1/1/90 – 12/31/04

Product Codes: 113, 606, 809, 820, 887-888, 1062, 1400-1464

Narrative/Text contains: 'CO\_' or 'CARB' or 'MONO'

**APPENDIX B**

Document Number	Investigation Task Number
NEISS	980901HEP5441
NEISS	981118HEP1681
NEISS	990903HEP1683
NEISS	020705HEP9005
NEISS	020724HEP9004
NEISS	021219HEP9012
NEISS	030403HEP9001
NEISS	030403HEP9018
NEISS	031009HEP9007
NEISS	040901HEP9010
NEISS	041112HEP9004
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0022034412	010628HCC2616
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0129025962	020219HCC2228
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