



# **Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 2007 Annual Estimates**

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January, 2011

*This analysis was prepared by the CPSC staff and 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 provides information about the estimated number of unintentional non-fire deaths attributed to carbon monoxide (CO) poisoning that were associated with the use of consumer products in 2007, and companion statistics since 1999. It should be noted that U.S. Consumer Product Safety Commission (CPSC) staff continues to receive reports of CO poisoning fatalities and the estimates may change in subsequent reports.

Some of the key findings in this report are:

For 2007:

- There were an estimated 183 unintentional non-fire CO poisoning deaths associated with consumer products under the CPSC's jurisdiction. The estimated annual average from 2005 through 2007 was 184 deaths.<sup>1</sup>
- *Heating Systems* were associated with the largest percentage of non-fire CO poisoning fatalities at 38 percent (estimated 70 deaths). *Engine-Driven Tools*-related CO fatalities were also associated with 38 percent (69 deaths), and the remaining six product categories [*Charcoal Grills or Charcoal* (7 deaths); *Ranges, Ovens* (7 deaths); *Water Heaters* (3 deaths); *Grills, Camp Stoves* (3 deaths); *Other Products* (1 death); and *Multiple Products* (24 deaths)] combined were associated with a total of 25 percent. There were no reported deaths in the *Lanterns – LP Fueled* category.

Generators and Other Engine-Driven Tools<sup>2</sup>:

- Of the estimated 69 CO fatalities in 2007 that were associated with *Engine-Driven Tools*, 93 percent (64 deaths) involved generators. Additionally, generator usage was associated with seven of the estimated 24 multiple appliance CO poisoning fatalities for a total of 71 deaths in which a generator was involved in the CO poisoning.
- The estimated 64 CO deaths associated with generators (71 including multiple product involvement) in 2007, represent a decrease from the estimated 88 deaths in 2005, and 84 deaths in 2006 (97 and 87 including multiple product involvement, respectively). However, with the exception of 2005 and 2006, the estimated number of generator-associated CO deaths in 2007, is greater than any other year covered in this report. On average, there were 33 generator-related CO fatalities (including multiple product involvement) per year from 1999 through 2004. The 2007 estimate of 71 deaths is more than double the average for that time period.

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<sup>1</sup> Not all of these fatalities are addressable by an action the CPSC could take; however, it was not the purpose of this report to evaluate the addressability of the incidents but rather to update the estimates of the number of consumer product associated CO poisoning deaths.

<sup>2</sup> Numbers presented in this document represent national estimates of unintentional non-fire deaths attributed to CO poisoning that were associated with the use of consumer products and not observed counts as presented in the CPSC report *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2009*.

#### Heating Systems:

- Of the estimated 70 *Heating Systems*-related fatalities in 2007, 87 percent (61 deaths) involved gas heating. Natural gas heating accounted for 43 percent (30 deaths) of heating system-related fatalities; liquefied petroleum (LP or propane) gas heating accounted for 40 percent (28 deaths); and an additional 4 percent (3 deaths) were identified only as unspecified gas heating. Kerosene- (4 deaths) and oil-fueled (5 deaths) heating systems accounted for the remaining 13 percent.

#### Location/Demographics:

- CPSC staff has received records of 115 fatal non-fire CO incidents involving consumer products resulting in 137 deaths in 2007. Eighty-five percent of these incidents (98 deaths) involved a single fatality.
- Seventy-nine percent (145 deaths) of the estimated 183 CO deaths in 2007 occurred in a home; while an estimated 14 percent (26 deaths) occurred in tents, camper trailers, and other temporary shelters.
- More CO fatalities occur in the colder months of the year. In 2007, 57 percent (104 of 183 deaths) occurred during the colder months of November, December, January, and February.
- In the three most recent years of this report (2005 through 2007), adults 45 years and older comprised an annual average of 60 percent of all non-fire consumer product-related CO deaths, while this age group makes up only about 37 percent of the U.S. population. Conversely, children less than 15 years of age accounted for an annual average of 5 percent of the yearly CO poisoning deaths, while this age group makes up about 20 percent of the U.S. population.
- In 2007, 69 percent (an estimated 126 deaths) of CO poisoning victims were males, and 31 percent (57 deaths) were females. This ratio is slightly different than the average observed from 1999 through 2007, where 74 percent of fatalities were male.
- Country of origin does not appear to be a significant factor in CO poisoning deaths. From 2005 through 2007, 86 percent of all non-fire CO poisoning victims were born in the United States, while approximately 88 percent of the U.S. population was born in the United States (based on the average of U.S. Census Bureau estimates for 2005 to 2007).
- Statistical tests indicate that the proportion of CO fatalities, broken down by race/ethnicity, differs from the proportion of people in the United States with ethnic backgrounds. Black or African American victims accounted for 18 percent of all CO poisoning fatalities in 2005 through 2007, even though Blacks or African Americans represented an average of only 12 percent of the U.S. population during that time period.
- CO poisoning fatalities occurring in isolated locations (including homes) account for a larger proportion of all CO fatalities (14 percent in 2005 through 2007) in comparison to the proportion of the U.S. population living in isolated areas (4 percent). When looking at only non-home locations, the disparity is even higher. CO fatalities at isolated non-home locations accounted for 32 percent of all CO fatalities occurring at non-home locations.

#### Historical Data:

- Regression models indicate that there is a statistically significant increasing trend in non-fire CO fatalities from 1999 through 2007.
- The CO poisoning three-year average mortality rate for 2005 through 2007 associated with consumer products (6.18 per 10 million population) has increased approximately 41 percent from the 1999 through 2000 average of 4.37 per 10 million population. However, for non-engine-driven tool products, the mortality rate has decreased by 15 percent since 1999 through 2000, from 3.67 in 1999 through 2000, to a 3.12 average mortality rate in 2005 through 2007. The increase in the mortality rate of consumer product-related CO poisoning is due to the mortality rate of CO poisoning from engine-driven tools more than quadrupling in the same time period, increasing from 0.69 in 1999 through 2000, to a 3.06 average for 2005 through 2007. Details are given in Appendix B of this report.

## Introduction

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas that results from the incomplete combustion of fuels such as natural or liquefied petroleum (LP) gas, gasoline, oil, wood, coal, and other fuels. The health effects related to CO depend upon its concentration in the blood, which in turn, depends on its concentration in the air, the duration of exposure, and each individual's general health. Carbon monoxide combines with hemoglobin (Hb) with an affinity about 250 times that of oxygen, forming carboxyhemoglobin (COHb) and interfering with oxygen transport, delivery, and utilization. Generally, there are no perceptible health effects or symptoms in healthy individuals at COHb levels below 10 percent. Symptoms associated with blood levels at or above 10 percent COHb include: headache, fatigue, nausea, and cognitive impairment. Loss of consciousness, coma, and death can occur at COHb levels greater than 20 percent, although for healthy adults, CO fatalities typically require levels above 50 percent COHb.<sup>3</sup>

Some symptoms of CO poisoning may mimic common illnesses, such as influenza or colds; thus, there likely is a high incidence of initial misdiagnosis by physicians and victims (Long and Saltzman, 1995). Frequently, patients are unaware of exposures, and health care providers may not always consider CO poisoning a cause of such nonspecific symptoms. COHb formation is reversible, as are some clinical symptoms of CO poisoning. However, some delayed neurological effects that develop following severe poisonings, especially those involving prolonged unconsciousness, may not be reversible. Prompt medical attention is important to reduce the risk of permanent damage.

Any fuel-burning appliance can be a potential source of fatal or hazardous CO levels. Fuels, such as natural and LP gas, kerosene, oil, coal, and wood can produce large amounts of CO when there is insufficient oxygen available for combustion. Consumer products that burn kerosene, oil, coal, or wood (such as wood stoves, oil boilers, and kerosene heaters) produce an irritating smoke, which can alert the victim to a potentially hazardous situation that can include lethal and elevated levels of undetectable CO gases. Engine-driven tools powered by gasoline produce large amounts of CO, even when they are run where there is sufficient oxygen available for combustion. Yet, they may not emit an irritating exhaust smoke. Other fuels, such as charcoal briquettes and pressed woodchip logs, produce relatively smokeless fires, even at times of inefficient combustion. In these cases, victims receive no obvious sensory warning that high CO levels are present. Another hazard scenario is present when gas appliances are not vented properly or are malfunctioning. Natural and LP gas burn more efficiently and cleanly compared with other forms of fuel. In circumstances of poor maintenance, inadequate ventilation, or faulty exhaust pathways, natural and LP gas appliances may emit potentially lethal amounts of CO without any irritating fumes. Again, many victims may be unaware of a potential problem.

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<sup>3</sup> 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.

## National Estimates of Non-Fire CO Poisoning Deaths Associated with Consumer Products

During 2007, there were an estimated 183 carbon monoxide poisoning deaths associated with the use of a consumer product under the jurisdiction of the U.S. Consumer Product Safety Commission (CPSC). The estimates presented in this report are based on nearly complete reporting of consumer product-related CO poisoning fatalities that occurred in 2007. The National Center for Health Statistics (NCHS) has records of every death certificate filed in the United States and its territories. A comparison of CPSC records to NCHS records indicates that CPSC records have data on approximately 75 percent of all the fatal CO poisoning deaths that occurred in 2007 in the United States. For the eight years covered in this report prior to 2007, CPSC records contain approximately 90 percent of all the fatal CO poisoning deaths that occurred in the United States and were reported to NCHS. As of June 10, 2010, the date the data were pulled for this report, the CPSC had not received death certificates from a number of states. It is unclear at this time what impact the lower-than-historically-observed percentage of all CO fatalities in CPSC records will have on future estimates. Future reports will update the 2007 estimates with the inclusion of death certificate data from the states that were not available to CPSC staff. Carbon monoxide poisoning deaths referred to in this report do not include those in which the CO gas resulted from a fire or a motor vehicle; those that were intentional in nature; or those that were related directly to work.

Although there can be multiple factors contributing to a CO poisoning fatality, the source of CO is virtually always a fuel-burning product. As mentioned earlier, poor product maintenance by professionals or consumers, inadequate ventilation, faulty exhaust pathways, and poor judgment by the user in operating these products can result in fatal scenarios. It should be noted that CPSC staff produces the CO estimates by associated consumer products to identify product groups involved in fatal CO scenarios and to monitor this distribution over time. It is within the individual, product-specific CPSC projects that further analysis is done to consider whether improvements are warranted in the areas of product design, ventilation safeguards, or user information and education.

The annual CO estimates for the years 1999 through 2007 are presented in two formats: (1) by product type (Table 1), and (2) by product within fuel type (Table 2). The data are presented as yearly estimates for each of the nine years covered by this report and as an average of the most recent three year period (2005 through 2007). Data collection is nearly complete for 2007 at this time. Estimates for this year may change in the future if additional data become available and, therefore, are reported using italic font in the tables.

**It should be noted that numbers presented in this document represent national estimates of unintentional non-fire deaths attributed to CO poisoning that were associated with the use of consumer products. Generator and other Engine-Driven Tools (EDT) death estimates would not be expected to match observed fatality counts presented in the CPSC report “Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2009.”**

Table 1 presents the consumer product distribution of CO poisoning deaths. The estimate for *Heating Systems*, historically a large percentage of the consumer product estimate, is broken down into heater system subcategories and is further distributed among the various fuel types. Fatality estimates for the *Engine-Driven Tools* category are distributed further between generators and other engine-driven tools. The consumer product estimate and product distributions were derived using the methodology described in Appendix A.

Of the estimated 183 CO poisoning deaths associated with a consumer product that occurred between January 2007 and December 2007, heating systems were associated with 70 deaths (38 percent of the total consumer product estimate). Of the 70 deaths associated with heating systems, the majority (87 percent or 61 fatalities) involved gas heating systems. Among gas heating systems, natural gas heating was associated with an estimated 30 deaths (43 percent of heating system-related deaths); liquid petroleum gas (LP gas)<sup>4</sup> heating was associated with an estimated 28 deaths (40 percent of heating system-related deaths); and unspecified gas heating was associated with an estimated three deaths (4 percent of heating system-related deaths). Kerosene and oil heating was associated with an estimated nine deaths (13 percent of heating system-related deaths). There are no reported coal/wood heating system or diesel-fueled heating system fatalities in the 2007 data. Additionally, in 2007, there were no reported CO deaths associated with heating systems with unknown fuel sources.

Of the estimated 30 deaths in 2007 that were associated with natural gas heating systems, all 30 involved installed furnaces—seven (23 percent) were described as wall or floor furnaces. Of the estimated 28 deaths in 2007 that were associated with LP gas heating systems, 17 (61 percent) involved unvented portable propane heaters. These unvented portable propane heaters were fueled by a propane tank and were not a component of an installed heating system.

In 2007, an estimated seven CO deaths (4 percent of the 183 total consumer product estimate) were associated with charcoal or charcoal grills; an estimated seven deaths (4 percent) were associated with gas ranges or ovens; an estimated three deaths (2 percent) were associated with gas water heaters; an estimated three deaths (2 percent) were associated with a subcategory of products that includes gas grills and camp stoves; and one death was associated with an unspecified gas fireplace. Additionally, in 2007, an estimated 24 deaths were associated with multiple appliances (13 percent of the total consumer product estimate). The *Multiple Products* category includes all incidents in which multiple fuel-burning products were used simultaneously such that a single source of the CO could not be determined. An estimated 24 CO fatalities were associated with multiple products. The most common scenario involved the simultaneous use of some type of LP heater and another fuel-burning product. An estimated 12 CO fatalities were associated with LP heaters and another fuel-burning product—an estimated five (from four incidents) were associated with the simultaneous use of an LP heater and a gasoline-fueled generator. The second most common scenario involved the simultaneous use of a natural gas furnace and a natural gas water heater resulting in an estimated five fatalities occurring in four incidents.

An estimated 69 CO poisoning deaths (38 percent of the estimated total from 2007) were associated with engine-driven tools, which includes generators, riding mowers or garden tractors, a snow blower, and a water pump. Generator associated deaths comprise the majority of this category. There were an estimated 64 generator-related CO poisoning deaths in 2007 (93 percent of all engine-driven tool fatalities and more than one-third (35 percent) of the total consumer product estimate). The estimated number of CO fatalities associated with engine-driven tools (69 deaths) in 2007 was very similar to the number associated with heating systems (70 deaths). In the prior two years (2005 and 2006), there were more CO fatalities associated with engine-driven tools than with heating systems. There were an estimated combined total of 205 engine-driven tool-related CO fatalities in 2005 and 2006, compared to only 101 deaths for heating systems. (These figures exclude fatalities associated with multiple products, because

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<sup>4</sup> In this document, references to Liquid Petroleum gas, or LP gas, also includes propane and butane gases, the two primary components of LP gas.

these possibly could be categorized in both categories.) In all other years prior to 2005 covered by this report, heating system-related categories were associated with the largest proportion of CO fatalities.

Table 1 shows the estimated average annual number of CO poisoning deaths associated with a consumer product for 2005–2007. The average yearly total number of CO deaths for this three-year period is estimated to be 184 (with a standard error of approximately 4.1). The 95 percent confidence interval<sup>5</sup> for this estimated average ranged from 167 to 202 deaths. Appendix B contains a graph and the data point values for the annual estimates of CO poisoning deaths associated with a consumer product for 1980 through 2007.

Detailed information regarding the conditions of products associated with fatalities was not collected reliably, and the availability of such information in the CPSC's files varied widely. However, information collected often did describe conditions regarding compromised vent systems, flue passageways, and chimneys for furnaces, boilers, and other heating systems. Vent systems include the portion of piping that connects the flue outlet of the appliance and exhausts air to the outside through a ceiling or sidewall, or connects to a chimney. Some vented products had vents that became detached or were installed or maintained improperly. Vents were also blocked sometimes by soot caused by inefficient combustion, which in turn, may have been caused by several factors, such as leaky or clogged burners, an over-firing condition, or inadequate combustion air.

Other conditions related to furnaces included compromised heat exchangers or filter doors or covers that were removed or not sealed. Some products were old and apparently poorly maintained, such that there were several factors involved in generating and exacerbating the amount of CO produced. Other incidents cited a backdraft condition, large amounts of debris in the chimney, and the use of a product that was later red-tagged by the utility company (taken out of commission by the utility company and not to be turned on until repaired).

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<sup>5</sup> Confidence interval based on a t-distribution with two degrees of freedom.

**Table 1: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Associated Fuel-Burning Consumer Product, 1999–2007**

Consumer Product	2005–2007 <sup>+</sup>		Annual Estimates								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>184</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
<b>Heating Systems</b>	<b>57</b>	<b>31%</b>	<b>50</b>	<b>82</b>	<b>71</b>	<b>94</b>	<b>67</b>	<b>85</b>	<b>52</b>	<b>49</b>	<b>70</b>
<b>Furnaces</b>	<b>26</b>	<b>14%</b>	<b>22</b>	<b>37</b>	<b>26</b>	<b>48</b>	<b>29</b>	<b>44</b>	<b>19</b>	<b>31</b>	<b>28</b>
Coal	*	*	*	1	1	1	*	1	*	*	*
Liquid Petroleum (LP) Gas	3	2%	5	7	7	16	3	9	1	9	*
Natural Gas	16	9%	15	25	10	21	19	23	6	19	23
Oil	2	1%	*	4	3	3	1	*	2	*	5
Unspecified Gas	1	1%	1	*	1	1	2	4	3	*	*
Unspecified Fuel	3	2%	1	*	3	5	4	8	7	3	*
<b>Portable Heaters</b>	<b>19</b>	<b>10%</b>	<b>16</b>	<b>20</b>	<b>17</b>	<b>26</b>	<b>25</b>	<b>20</b>	<b>23</b>	<b>14</b>	<b>21</b>
Diesel	*	*	*	*	*	1	*	*	*	*	*
Kerosene	3	2%	3	3	1	4	5	4	2	3	4
Liquid Petroleum (LP) Gas	15	8%	12	14	16	20	18	15	19	10	17
Natural Gas	*	*	1	2	*	*	2	*	*	*	*
Unspecified Gas	< 1	< 1%	*	*	*	*	*	1	1	*	*
Unspecified Fuel	1	1%	*	*	*	*	*	*	1	1	*
<b>Wall/Floor Furnaces</b>	<b>5</b>	<b>3%</b>	<b>6</b>	<b>14</b>	<b>19</b>	<b>9</b>	<b>4</b>	<b>6</b>	<b>2</b>	<b>2</b>	<b>12</b>
Liquid Petroleum (LP) Gas	2	1%	3	5	2	4	1	5	*	*	5
Natural Gas	4	2%	2	9	14	4	3	1	2	2	7
Oil	*	*	*	*	1	*	*	*	*	*	*
Unspecified Fuel	*	*	*	*	2	*	*	*	*	*	*
<b>Room/Space Heaters</b>	<b>6</b>	<b>3%</b>	<b>6</b>	<b>10</b>	<b>8</b>	<b>11</b>	<b>8</b>	<b>12</b>	<b>8</b>	<b>1</b>	<b>8</b>
Coal	< 1	< 1%	*	*	3	*	*	1	1	*	*
Liquid Petroleum (LP) Gas	2	1%	3	1	1	*	1	*	*	*	5
Natural Gas	< 1	< 1%	1	7	2	6	3	6	*	1	*
Wood	1	1%	*	1	1	1	2	*	2	*	*
Unspecified Gas	1	1%	1	*	*	3	2	4	1	*	3
Unspecified Fuel	1	1%	*	1	*	*	*	*	3	*	*
<b>Unspecified Heater/System</b>	<b>&lt; 1</b>	<b>&lt; 1%</b>	<b>*</b>	<b>1</b>	<b>*</b>	<b>1</b>	<b>*</b>	<b>2</b>	<b>*</b>	<b>*</b>	<b>1</b>
Liquid Petroleum (LP) Gas	< 1	< 1%	*	1	*	*	*	*	*	*	1
Unspecified Gas	*	*	*	*	*	1	*	2	*	*	*

**Table 1 (continued)**

Consumer Product	2005-2007 <sup>+</sup>		Annual Estimates								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Engine-Driven Tools</b>	<b>91</b>	<b>49%</b>	<b>13</b>	<b>26</b>	<b>21</b>	<b>50</b>	<b>56</b>	<b>56</b>	<b>103</b>	<b>102</b>	<b>69</b>
Generators	79	43%	7	19	20	41	49	42	88	84	64
Other Engine-Driven Tools	13	7%	6	8	1	10	7	14	15	18	5
<b>Charcoal Grills, Charcoal</b>	<b>8</b>	<b>4%</b>	<b>17</b>	<b>8</b>	<b>10</b>	<b>11</b>	<b>8</b>	<b>3</b>	<b>6</b>	<b>10</b>	<b>7</b>
<b>Gas Ranges or Ovens</b>	<b>4</b>	<b>2%</b>	<b>6</b>	<b>12</b>	<b>9</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>6</b>	<b>*</b>	<b>7</b>
Liquid Petroleum (LP) Gas	1	1%	3	1	2	*	*	1	1	*	1
Natural Gas	1	1%	2	5	1	3	*	2	1	*	1
Unspecified Gas	2	1%	*	5	6	*	3	1	3	*	4
<b>Gas Water Heaters</b>	<b>4</b>	<b>2%</b>	<b>1</b>	<b>3</b>	<b>*</b>	<b>1</b>	<b>7</b>	<b>2</b>	<b>6</b>	<b>4</b>	<b>3</b>
Liquid Petroleum (LP) Gas	1	1%	*	*	*	*	3	1	2	*	1
Natural Gas	1	1%	*	2	*	1	3	*	*	3	*
Unspecified Gas	2	1%	1	1	*	*	1	1	3	1	1
<b>Lanterns - Liquid Petroleum (LP) Gas Fueled</b>	<b>3</b>	<b>2%</b>	<b>8</b>	<b>3</b>	<b>*</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>6</b>	<b>3</b>	<b>*</b>
<b>Grills, Camp Stoves</b>	<b>2</b>	<b>1%</b>	<b>5</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>3</b>	<b>*</b>	<b>2</b>	<b>3</b>
Kerosene	*	*	*	*	*	*	*	1	*	*	*
Liquid Petroleum (LP) Gas	1	1%	5	1	1	4	1	2	*	1	1
Unspecified Fuel	1	1%	*	*	*	*	*	*	*	1	1
<b>Other Products</b>	<b>1</b>	<b>1%</b>	<b>2</b>	<b>*</b>	<b>*</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>*</b>	<b>1</b>
Chimney - Unspecified Fuel	< 1	< 1%	*	*	*	*	*	*	1	*	*
Fireplace - Unspecified Gas	< 1	< 1%	*	*	*	*	*	*	*	*	1
Fireplace - Wood	*	*	*	*	*	2	*	2	*	*	*
Other Products - Liquid Petroleum (LP) Gas	< 1	< 1%	1	*	*	*	2	*	1	*	*
Other Products - Natural Gas	< 1	< 1%	1	*	*	*	*	*	1	*	*
Unidentified Product	*	*	*	*	*	*	*	1	*	*	*
<b>Multiple Products</b>	<b>14</b>	<b>8%</b>	<b>6</b>	<b>2</b>	<b>8</b>	<b>13</b>	<b>8</b>	<b>7</b>	<b>12</b>	<b>7</b>	<b>24</b>

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File,

National Center for Health Statistics Mortality File, 1999 - 2007.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 2 organizes the estimates by product within fuel type. The three major fuel types include: (1) *Gas-Fueled Products* (natural gas and liquid petroleum [LP or propane] gas); (2) *Solid-Fueled Products* (charcoal, coal, and wood); and (3) *Liquid-Fueled Products* (gasoline, kerosene, and oil). Of these fuel types, *Gas-Fueled Products* were associated with 87 of the 183 (48 percent) estimated CO fatalities in 2007. *Liquid-Fueled Products* and *Solid-Fueled Products* were associated with 81 (44 percent) and seven (4 percent) estimated fatalities in the same time period, respectively. An additional five (3 percent) fatalities were associated with multiple products, where there were two or more different categories of fuel used. Multiproduct cases, where the fuel types were the same, are counted in their respective category summary. There was also one (1 percent) fatality in 2007 associated with consumer products where the fuel type was unknown.

In the *Gas-Fueled Products* category, the vast majority of CO fatalities in 2007 were associated with heating-related products. Of the estimated 87 gas-fueled appliance fatalities in 2007, 62 (71 percent) were associated with heating systems or heaters including furnaces and boilers, portable heaters, wall or floor heaters, room or space heaters, or fireplaces. Additionally, all of the estimated 15 fatalities in the *Multiple Gas-Fueled Products* category involved some type of gas heater. Of the estimated 81 liquid-fueled appliance-related fatalities in 2007, 69 (85 percent) were associated with engine-driven tools (generators, lawn mowers/garden tractors, power washers). Generators accounted for 64 of the estimated 81 fatalities (79 percent) in the *Liquid-Fueled Products* category for 2007. In 2007, all of the estimated seven fatalities in the *Solid-Fueled Products* category were associated with charcoal or charcoal grills. Additionally, there were an estimated five CO fatalities associated multiple products of different fuel types like generators (liquid-fueled) and portable LP heaters (gas-fueled).

**Table 2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products Organized by Fuel Type, 1999-2007**

Consumer Product	2005 – 2007 <sup>+</sup>		Annual Estimates								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>184</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
<b>Gas-Fueled Products</b>	<b>64</b>	<b>35%</b>	<b>72</b>	<b>91</b>	<b>66</b>	<b>93</b>	<b>70</b>	<b>87</b>	<b>54</b>	<b>51</b>	<b>87</b>
<b>Natural Gas</b>	<b>22</b>	<b>12%</b>	<b>23</b>	<b>50</b>	<b>28</b>	<b>36</b>	<b>30</b>	<b>32</b>	<b>10</b>	<b>26</b>	<b>30</b>
Furnace	16	9%	15	25	10	21	19	23	6	19	23
Pool Heater	< 1	< 1%	1	*	*	*	*	*	1	*	*
Portable Heater	*	*	1	2	*	*	2	*	*	*	*
Range/Oven	1	1%	2	5	1	3	*	2	1	*	1
Room/Space Heater	< 1	< 1%	1	7	2	6	3	6	*	1	*
Wall/Floor Furnace	4	2%	2	9	14	4	3	1	2	2	7
Water Heater	1	1%	*	2	*	1	3	*	*	3	*
<b>Liquid Petroleum (LP) Gas</b>	<b>29</b>	<b>16%</b>	<b>40</b>	<b>34</b>	<b>30</b>	<b>47</b>	<b>31</b>	<b>38</b>	<b>30</b>	<b>23</b>	<b>33</b>
Furnace	3	2%	5	7	7	16	3	9	1	9	*
Grill/Camp Stove	1	1%	5	1	1	4	1	2	*	1	1
Lantern	3	2%	8	3	*	2	1	4	6	3	*
Other Products	*	*	*	*	*	*	1	*	*	*	*
Portable Heater	15	8%	12	14	16	20	18	15	19	10	17
Range/Oven	1	1%	3	1	2	*	*	1	1	*	1
Refrigerator	< 1	< 1%	1	*	*	*	1	*	1	*	*
Room/Space Heater	2	1%	3	1	1	*	1	*	*	*	5
Wall/Floor Furnace	2	1%	3	5	2	4	1	5	*	*	5
Water Heater	1	1%	*	*	*	*	3	1	2	*	1
Unspecified Heater	< 1	< 1%	*	*	*	*	*	*	*	*	1
<b>Unspecified Gas</b>	<b>7</b>	<b>4%</b>	<b>3</b>	<b>7</b>	<b>7</b>	<b>5</b>	<b>8</b>	<b>14</b>	<b>12</b>	<b>1</b>	<b>9</b>
Furnace	1	1%	1	*	1	1	2	4	3	*	*
Portable Heater	< 1	< 1%	*	*	*	*	*	1	1	*	*
Range/Oven	2	1%	*	5	6	*	3	1	3	*	4
Room/Space Heater	1	1%	1	*	*	3	2	4	1	*	3
Fireplace	< 1	< 1%	*	*	*	*	*	*	*	*	1
Water Heater	2	1%	1	1	*	*	1	1	3	1	1
Unspecified Heater	*	*	*	*	*	1	*	2	*	*	*
<b>Multiple Gas-Fueled Products</b>	<b>6</b>	<b>3%</b>	<b>5</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>15</b>

**Table 2 (continued)**

Consumer Product	2005–2007 <sup>+</sup>		Annual Estimates								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Liquid-Fueled Products</b>	<b>99</b>	<b>54%</b>	<b>16</b>	<b>35</b>	<b>28</b>	<b>63</b>	<b>65</b>	<b>61</b>	<b>109</b>	<b>106</b>	<b>81</b>
<b>Gasoline-Fueled</b>	<b>91</b>	<b>49%</b>	<b>13</b>	<b>26</b>	<b>21</b>	<b>50</b>	<b>56</b>	<b>56</b>	<b>103</b>	<b>102</b>	<b>69</b>
Liquid - Generator - Gasoline	79	43%	7	19	20	41	49	42	88	84	64
Liquid - OEDT - Gasoline	13	7%	6	8	1	10	7	14	15	18	5
<b>Kerosene-Fueled</b>	<b>3</b>	<b>2%</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>2</b>	<b>3</b>	<b>4</b>
Liquid - Grill/Camp Stove - Kerosene	*	*	*	*	*	*	*	4	*	*	4
Liquid - Portable Heater - Kerosene	3	2%	3	3	1	4	5	4	2	3	3
<b>Oil-Fueled</b>	<b>2</b>	<b>1%</b>	<b>*</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>1</b>	<b>*</b>	<b>2</b>	<b>*</b>	<b>5</b>
Liquid - Furnace - Oil	2	1%	*	4	3	3	1	*	2	*	5
Liquid - Wall/Floor Furnace - Oil	*	*	*	*	1	*	*	*	*	*	*
<b>Diesel-Fueled</b>	<b>*</b>	<b>*</b>	<b>*</b>	<b>*</b>	<b>*</b>	<b>1</b>	<b>*</b>	<b>*</b>	<b>*</b>	<b>*</b>	<b>*</b>
Liquid - Portable Heater - Diesel	*	*	*	*	*	1	*	*	*	*	*
<b>Multiple Liquid-Fueled Products</b>	<b>2</b>	<b>1%</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>*</b>	<b>2</b>	<b>*</b>	<b>3</b>
<b>Solid-Fueled Products</b>	<b>9</b>	<b>5%</b>	<b>17</b>	<b>10</b>	<b>16</b>	<b>15</b>	<b>10</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>7</b>
<b>Charcoal-Fueled</b>	<b>8</b>	<b>4%</b>	<b>17</b>	<b>8</b>	<b>10</b>	<b>11</b>	<b>8</b>	<b>3</b>	<b>6</b>	<b>10</b>	<b>7</b>
Charcoal / Charcoal Grills	8	4%	17	8	10	11	8	3	6	10	7
<b>Coal-Fueled</b>	<b>&lt; 1</b>	<b>&lt; 1%</b>	<b>*</b>	<b>1</b>	<b>5</b>	<b>1</b>	<b>*</b>	<b>2</b>	<b>1</b>	<b>*</b>	<b>*</b>
Furnace	*	*	*	1	1	1	*	1	*	*	*
Room/Space Heater	< 1	< 1%	*	*	3	*	*	1	1	*	*
<b>Wood-Fueled</b>	<b>1</b>	<b>1%</b>	<b>*</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>*</b>	<b>*</b>
Chimney/Fireplace	*	*	*	*	*	2	*	2	*	*	*
Room/Space Heater	1	1%	*	1	1	1	2	*	2	*	*
<b>Unspecified Fuel Products</b>	<b>6</b>	<b>3%</b>	<b>1</b>	<b>1</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>9</b>	<b>12</b>	<b>6</b>	<b>1</b>
Chimney	< 1	< 1%	*	*	*	*	*	*	1	*	*
Furnace	3	2%	1	*	3	5	4	8	7	3	*
Grill/Camp Stove	1	1%	*	*	*	*	*	*	*	1	1
Portable Heater	1	1%	*	*	*	*	*	*	1	1	*
Room/Space Heater	1	1%	*	1	*	*	*	*	3	*	*
Wall/Floor Furnace	*	*	*	*	2	*	*	*	*	*	*
Unidentified Product	*	*	*	*	*	*	*	1	*	*	*
<b>Multiple Product - Different Fuels</b>	<b>7</b>	<b>4%</b>	<b>1</b>	<b>*</b>	<b>5</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>9</b>	<b>6</b>	<b>5</b>
Gas & Liquid	6	3%	1	*	5	4	3	3	7	6	5
Gas & Solid	< 1	< 1%	*	*	*	*	*	*	1	*	*
Liquid & Solid	*	*	*	*	*	*	1	*	*	*	*
Gas & Liquid & Unspecified	< 1	< 1%	*	*	*	*	*	*	*	*	1

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File,

National Center for Health Statistics Mortality File, 1999–2007.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 3 shows a breakdown of the fatality estimates for the 9-year period from 1999 through 2007 in the *Engine-Driven Tools* category. During 2007, engine-driven tools were associated with an estimated 76 carbon monoxide poisoning deaths (42 percent of the total consumer product estimate). Table 3 totals differ from Tables 1 and 2 in that they also include fatalities associated with multiple potential CO producing products, where at least one product was an engine-driven tool. In 2007, there were seven such deaths—all associated with a generator and some other product (all seven involved portable LP heaters). These seven accounted for 9 percent of all engine-driven tool deaths. Sixty-four of these 76 engine-driven tool-related CO poisoning deaths (84 percent) were associated with generators alone; and five (7 percent) were associated with the classification *Other Engine-Driven Tools*. In 2007, the other engine-driven tool-related fatalities included an estimated three deaths that were associated with lawn mowers (this includes riding mowers, garden tractors, and gas-fueled powered push mowers); and one death each associated with a snow blower and a water pump. An additional seven deaths were associated with the use of a generator and another potentially CO producing product. Therefore, there were an estimated 71 non-fire CO fatalities associated with generators or generators and another potential CO producing product in 2007.

**Table 3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Engine-Driven Tools, 1999-2007**

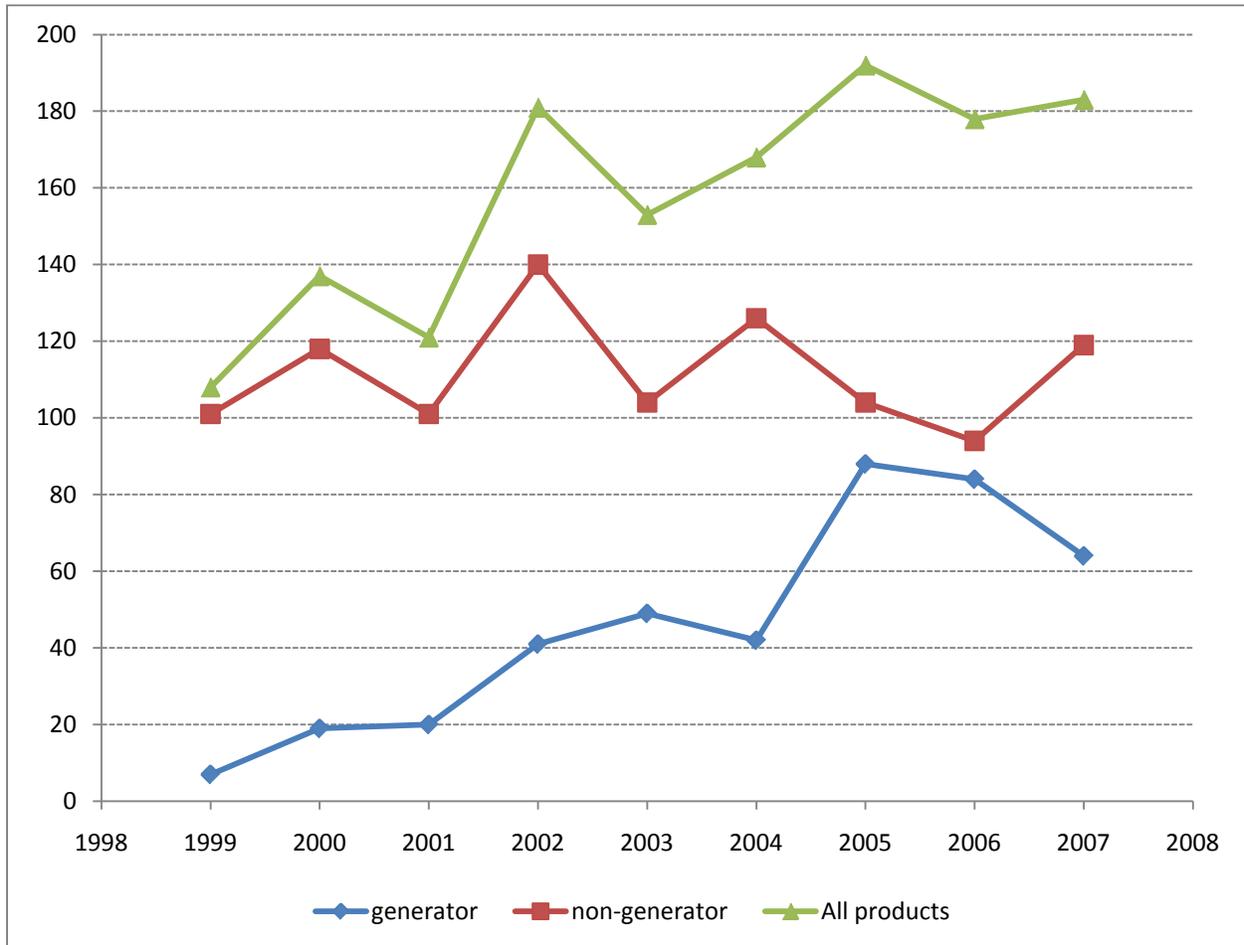
Engine-Driven Tools	2005-2007 <sup>+</sup> Average Estimate	Average Percentage	Annual Estimate								
			1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>97</b>	<b>100%</b>	<b>14</b>	<b>27</b>	<b>27</b>	<b>58</b>	<b>62</b>	<b>59</b>	<b>109</b>	<b>106</b>	<b>76</b>
<b>Generators</b>	<b>79</b>	<b>81%</b>	<b>7</b>	<b>19</b>	<b>20</b>	<b>41</b>	<b>49</b>	<b>42</b>	<b>88</b>	<b>84</b>	<b>64</b>
<b>Other Engine-Driven Tools</b>	<b>13</b>	<b>13%</b>	<b>6</b>	<b>8</b>	<b>1</b>	<b>10</b>	<b>7</b>	<b>14</b>	<b>15</b>	<b>18</b>	<b>5</b>
Lawn Mowers <sup>1</sup>	8	8%	6	7	1	5	6	8	9	11	3
Power Washer	1	1%	*	*	*	*	*	2	3	1	*
Snow Blower	1	1%	*	1	*	*	*	*	1	1	1
ATV	< 1	< 1%	*	*	*	1	*	1	1	*	*
Water Pump	1	1%	*	*	*	*	*	1	*	1	1
Welder	*	*	*	*	*	2	1	*	*	*	*
Air Compressor	< 1	< 1%	*	*	*	*	*	1	*	1	*
Concrete Saw	*	*	*	*	*	1	*	1	*	*	*
Small Engine	< 1	< 1%	*	*	*	*	*	*	*	1	*
Snowmobile	< 1	< 1%	*	*	*	*	*	*	*	1	*
<b>Multiple Product: Engine-Driven Tools Involved</b>	<b>6</b>	<b>6%</b>	<b>1</b>	<b>1</b>	<b>6</b>	<b>8</b>	<b>6</b>	<b>3</b>	<b>9</b>	<b>3</b>	<b>7</b>
Generator + OEDT	*	*	*	*	1	*	*	*	*	*	*
Generator + other product	6	6%	*	1	5	6	5	2	9	3	7
OEDT + other product	*	*	1	*	*	1	1	1	*	*	*

\* No reports received by CPSC staff.

As can be seen in Table 3, the estimated numbers of fatalities associated with engine-driven tools increased dramatically in 2005 and 2006 from previous years. In 2007, the number of CO fatalities associated with engine-driven tools dropped, but is still above the estimates for years prior to 2005. Whether 2005 and 2006 represented an upward spike or 2007 was a downward spike is unclear at this time and may become clear in the years to come. Although estimated 2007 engine-driven tools fatalities are 30 percent below the 2005 peak year, the estimate is still 27 percent above the 2002–2004 estimated annual average of 60 deaths and 85 percent above the 1999–2004 estimated annual average of 41 deaths. The estimated number of generator-related fatalities (including multiple product incidents) dropped from 2005 and 2006

estimates. The 71 generator-related CO fatalities in 2007 is 47 percent above the estimated annual average of 48 deaths for 2002–2004, and more than double the 1999–2004 average of 33 deaths. Figure 1 provides a graphic representation of the CO fatality trends related to all consumer products; related to generators alone; and related to non-generator consumer products tools. A regression analysis of the estimated number of all non-fire, consumer product-related CO poisoning fatalities from 1999 to 2007, indicates that there is evidence of an upward trend in the data (p-value = 0.0043).

**Figure 1: Comparison of Trends in Consumer Product-Related Deaths–1999 to 2007**



The number of CO fatalities associated with the use of generators (including fatalities associated with generators and other potential CO producing products) nearly doubled in 2005 and 2006 from the previous three years, increasing from an estimated average of 48 fatalities in 2002 through 2004, to an estimated average of 92 in 2005 and 2006. Much of this increase in 2005 may be attributable to the unusually severe weather (mostly hurricanes and ice/snow storms), which knocked out power to a large number of consumers, who then turned to generators as an alternative power source. Nearly half of the generator-related CO fatalities in 2005 (an estimated 44 of 97, 45 percent) were associated with power outages caused by weather conditions. In 2006, however, a year with apparently milder weather, only an estimated 17 out of 87 (20 percent) of the generator-related CO fatalities were associated with severe weather-caused power outages. A partial explanation for the elevated 2006 estimates is the relatively high number of deaths associated with power disconnection by the utility company because of

billing disputes—23 (26 percent), compared to only 12 (12 percent) in 2005, and 13 (18 percent) in 2007. In 2007, an estimated 26 of the 71 (37 percent) CO deaths associated with generators were weather-related.

Lawnmowers were associated with two-thirds (56 of 84, or 67 percent) of the deaths in the *Other Engine-Driven Tools* category for the nine-year period. There were two other fatalities associated with a lawnmower and another product—one with a generator, and the other with a propane heater. There was an estimated average of eight lawnmower-related CO fatalities per year in 2005–2007. CO fatalities related to power washer usage was the next largest subcategory, with an estimated six deaths from 1999 to 2007.

Table 4 shows that in 2007, 85 percent of fatal CO incidents reported to the CPSC involved a single death. Table 4 accounts for only the fatally injured victims in each CO poisoning incident. It is not uncommon for CO incidents involving one or more fatalities to also result in one or more nonfatal CO poisoning injuries, but they were not quantified for analysis in this report. It should be noted that these are the incidents reported in the CPSC databases and do not represent the national estimates of fatalities per CO incident. Death certificates do not include information about other fatalities for the same incident. The number of fatalities for a particular incident is based on the CPSC’s In-Depth Investigation files and may include fatalities for which CPSC staff does not have death certificates. Some additional multiple fatality incidents were identified by matching date of death and location of death on death certificates, while others were identified from news articles contained in the CPSC Injury or Potential Injury Incident (IPII) database.

**Table 4: Number of Carbon Monoxide Poisoning Incidents Reported to CPSC by Number of Deaths Per Incident, 1999-2007.**

Number of Deaths Reported in Incident	2005-2007 <sup>+</sup>		Annual Incidents								
	Annual Average	Average Percent	1999	2000	2001	2002	2003	2004	2005 <sup>#</sup>	2006	2007 <sup>+</sup>
<b>Total Incidents</b>	<b><i>129</i></b>	<b><i>100%</i></b>	<b><i>78</i></b>	<b><i>103</i></b>	<b><i>88</i></b>	<b><i>132</i></b>	<b><i>121</i></b>	<b><i>127</i></b>	<b><i>148</i></b>	<b><i>123</i></b>	<b><i>115</i></b>
1	<i>105</i>	<i>81%</i>	63	81	71	104	97	105	124	94	98
2	<i>17</i>	<i>13%</i>	14	19	15	23	20	14	18	21	12
3	<i>5</i>	<i>4%</i>	*	2	2	1	3	7	5	6	5
4	<i>&lt; 1</i>	<i>&lt; 1%</i>	1	*	*	2	*	1	*	1	*
5	<i>&lt; 1</i>	<i>&lt; 1%</i>	*	*	*	2	1	*	*	1	*
6	<i>&lt; 1</i>	<i>&lt; 1%</i>	*	1	*	*	*	*	1	*	*

+ Data collection for 2007 is nearly complete. Italicized counts may change in the future if more reports of fatalities are received.

\* No incident reports received by CPSC staff for this time period.

# 2005 data include one case where there were two CO fatalities, but only one was considered in-scope for this report due to the work-related nature of the incident (one worker, one nonworker). This incident is identified in this table as a two-death incident, but only the non-work-related fatality is accounted for elsewhere in the report.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, 1999–2007.

Note 1: Data in Table 4 do not add to totals presented in Table 1. Data presented in Table 4 are not national estimates derived from NCHS totals, but reported deaths contained in the CPSC files. NCHS data do not contain enough detail to identify multiple victims of the same CO poisoning incident. These figures include fatalities reported in CPSC In-Depth Investigation files, for which the CPSC may not have a death certificate.

Note 2: 2005 data include one case where there were two CO fatalities, but only one was considered in-scope for this report due to the work-related nature of the incident (one worker, one nonworker). This incident is identified in this table as a two-death incident, but only the non-work-related fatality is accounted for elsewhere in the report.

Table 5 shows that in 2007, an estimated 145 CO poisoning deaths occurred in homes, including manufactured and mobile homes. From 2005 through 2007, an annual average of 143 CO poisoning deaths (78 percent) occurred in homes, including manufactured and mobile homes. In 2007, an estimated 26 deaths took place in temporary shelters, such as tents, seasonal cabins,

and trailers (including horse trailers where people were sleeping during a horse show, for example). For 2005 to 2007, an annual average of 30 CO poisoning deaths (16 percent) took place in temporary shelters. In 2007, CO deaths in temporary shelters most commonly were associated with portable gas or LP gas heating or with generators. An estimated 19 of 26 (73 percent) CO deaths in temporary shelters were associated with LP-fueled products, most commonly portable LP heaters (9 deaths or 47 percent). In 2007, an estimated four deaths (15 percent) in temporary shelters involved generators.

A consistently small percentage of deaths due to CO poisoning involving a consumer product occurred in vehicles, such as passenger vans, trucks, automobiles, recreational vehicles, campers, or boats. In 2007, there were an estimated 11 (6 percent) CO fatalities in this category—most commonly associated with charcoal and charcoal grills (three deaths) or generators (three deaths). For 2005 to 2007, an annual average of 10 CO poisoning deaths (5 percent) took place in vehicles.

**Table 5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Location of Death, 1999-2007.**

Location of Death	2005-2007 <sup>+</sup>		Annual Estimate								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>184</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
Home	143	78%	71	101	93	146	121	132	145	140	145
Temporary Shelter	30	16%	28	29	15	31	22	22	32	31	26
Vehicles (including boats)	10	5%	9	7	13	4	9	8	14	6	11
Other	1	1%	*	*	*	*	*	6	1	1	1
Unknown	*	*	*	*	*	*	2	*	*	*	*

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

Source: U.S. Consumer Product Safety Commission / EPA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999–2007.

CPSC data indicate that there were more CO fatalities in the colder months than there were in the warmer months. This is most likely because of the use of furnaces and portable heaters in the colder months. Additionally, generators often are used in the winter months because of power outages due to snow and ice storms. Table 6 shows the annual estimated CO fatalities categorized by month of death for the nine years covered by this report. In 2007, 104 of the 183 estimated CO fatalities (57 percent) occurred during the colder months of November, December, January, and February. In the transition months of March, April, September, and October, an estimated 50 fatalities occurred (27 percent); and in the warmer months of May, June, July, and August, an estimated 28 fatalities occurred (15 percent).

**Table 6: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Month of Year of the Fatality, 1999–2007.**

Location of Death	2005-2007 <sup>+</sup>		Annual Estimate								
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>184</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
<b>Cold Months</b>	<b>98</b>	<b>53%</b>	<b>59</b>	<b>88</b>	<b>86</b>	<b>94</b>	<b>96</b>	<b>107</b>	<b>99</b>	<b>92</b>	<b>104</b>
November	20	11%	7	28	13	27	32	25	17	23	19
December	30	16%	16	32	23	26	30	26	34	36	19
January	32	17%	28	17	28	21	22	36	39	12	45
February	17	9%	8	11	22	20	12	20	9	21	21
<b>Transition Months</b>	<b>57</b>	<b>31%</b>	<b>31</b>	<b>31</b>	<b>30</b>	<b>68</b>	<b>38</b>	<b>42</b>	<b>64</b>	<b>56</b>	<b>50</b>
March	19	10%	17	9	5	29	8	11	20	19	19
April	14	8%	2	3	13	9	13	8	10	16	15
September	8	4%	6	7	5	4	8	14	17	7	*
October	16	9%	6	12	7	26	9	9	17	14	16
<b>Warm Months</b>	<b>29</b>	<b>16%</b>	<b>18</b>	<b>18</b>	<b>7</b>	<b>19</b>	<b>19</b>	<b>20</b>	<b>31</b>	<b>29</b>	<b>28</b>
May	8	4%	3	7	5	4	3	3	4	9	11
June	5	3%	5	3	*	5	7	8	9	3	4
July	5	3%	5	5	*	2	6	5	11	4	1
August	11	6%	5	3	2	8	3	4	7	13	12

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

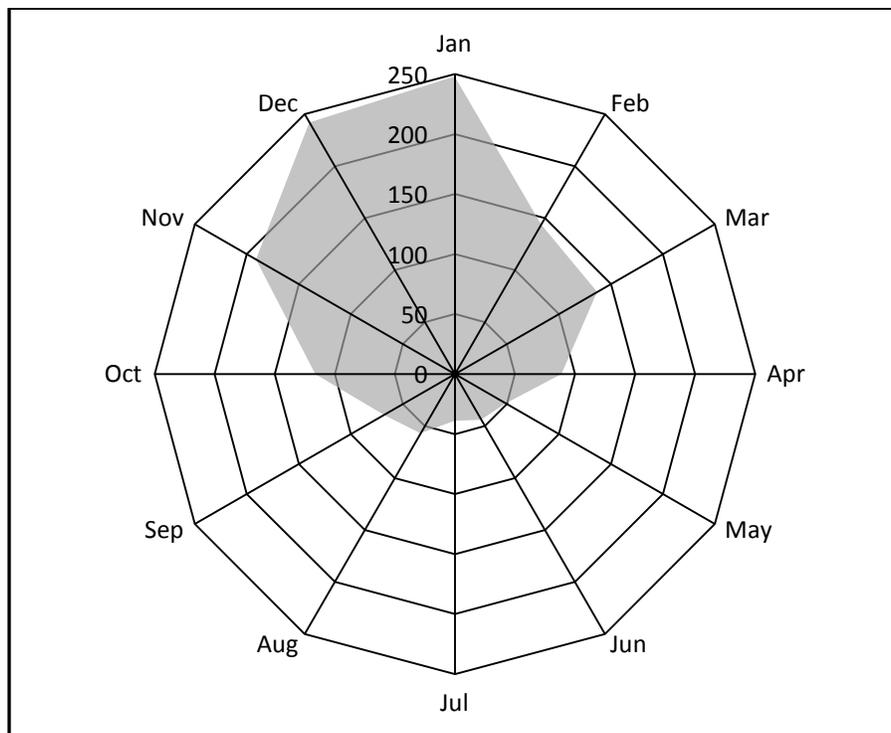
\* No reports received by CPSC staff.

Source: U.S. Consumer Product Safety Commission / EPHA.  
 CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999–2007.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Figure 2 illustrates the relationship between the time of year and the number of CO poisoning fatalities. The total estimated number of CO poisoning fatalities is presented by month of death on the radar graph. The shaded area represents the estimated total number of fatalities for 1999 through 2007 for each month. It can be seen clearly that more CO deaths occur in the colder months, specifically, November, December, and January, than in warmer months. It also can be seen that as the months get colder after the summer, the number of CO fatalities increases. Conversely, as the months get warmer after the winter, the number of fatalities decreases.

**Figure 2: Estimated Number of Consumer Product-Related Carbon Monoxide Deaths by Month of Death, 1999–2007**



### **Demographics of Fatalities from Non-Fire Carbon Monoxide Poisoning Associated with the Use of Consumer Products**

Table 7 shows the estimated number of CO poisoning fatalities categorized by victim age for the nine most recent years of data (1999–2007). To assess whether any particular age groups appeared to have a disproportionate risk of fatal CO poisoning, staff compared the age distribution of all fatal CO poisoning victims with the age distribution of the U.S. population. From the summary, it appears that consumer product-related CO fatalities are skewed toward older individuals. For the three most recent years (2005–2007), children younger than 15 years of age accounted for an annual average of 5 percent (an estimated 9 of 184) of the yearly CO poisoning deaths, while this age group represents an average of up to about 20 percent of the U.S. population. The annual average percentage of deaths represented by adults 45 years and older was 60 percent (111 of 184) in 2005–2007, while only about 37 percent of the U.S. population is over 45 years old. In 2005 to 2007, adults aged 65 years and older accounted for an annual average percentage of 21 percent of CO poisoning fatalities, although this age group is about 12 percent of the U.S. population.<sup>6</sup> The following statistical tests confirm that adults over 45 years of age comprise a disproportionate share of the product-related CO fatalities, indicating that their risk of a CO poisoning fatality is significantly increased compared to other age groups. Chi-square goodness-of-fit test results indicate that there is a statistically significant difference ( $p\text{-value} = < 0.0001$ ) between the proportion of CO victims in each age group and that of the general U.S. population. Binomial tests were performed to determine which victim age group proportion was significantly different from the respective proportion in the U.S. population. The tests indicated that three groups were found to be significantly different than what would be

<sup>6</sup> U.S. Census Bureau, Statistical Abstract of the United States: 2009.

expected if there was no population group effect:

1. The “Under 15” group<sup>7</sup> was significantly lower.
2. The “45–64” group was significantly higher.
3. The “65 and older” group was significantly higher.

**Table 7: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Age of Victim, 1999-2007.**

Age	2005-2007 <sup>+</sup>		Estimated Percentage of US Population <sup>#</sup>	Annual Estimate								
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b><i>184</i></b>	<b><i>100%</i></b>	<b><i>100%</i></b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
Under 5	<i>3</i>	<i>2%</i>	<i>7%</i>	*	3	3	2	6	3	*	2	8
5 - 14	<i>6</i>	<i>3%</i>	<i>13%</i>	7	3	6	9	9	11	7	4	7
15 - 24	<i>18</i>	<i>10%</i>	<i>14%</i>	8	10	16	11	17	4	15	20	20
25 - 44	<i>46</i>	<i>25%</i>	<i>28%</i>	31	42	22	57	46	44	46	59	32
45 - 64	<i>72</i>	<i>39%</i>	<i>25%</i>	45	56	40	51	55	67	87	57	71
65 and over	<i>39</i>	<i>21%</i>	<i>13%</i>	16	23	33	51	20	39	36	36	45

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

# Based on average estimated U.S. population statistics for 2005 to 2007.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999 - 2007.

U.S. Census Bureau, Statistical Abstract of the United States: 2009.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 8 presents the distribution of estimated CO fatalities categorized by gender. In 2007, 69 percent of CO poisoning victims were males, and 31 percent were females. These percentages varied slightly from year to year over the nine years of this report, but every year there are many more male CO fatalities than female. Over the years 1999 through 2007, the average percentage of male CO victims was 74 percent, and the average percentage of female victims was 26 percent. By contrast, about 49 percent of the U.S. population is male, and 51 percent is female.<sup>8</sup>

**Table 8: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Gender of Victim, 1999–2007.**

Gender	2005-2007 <sup>+</sup>		Estimated Percentage of US Population <sup>#</sup>	Annual Estimate								
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b><i>184</i></b>	<b><i>100%</i></b>	<b><i>100%</i></b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
Male	<i>137</i>	<i>74%</i>	<i>49%</i>	86	103	82	128	117	123	142	142	126
Female	<i>48</i>	<i>26%</i>	<i>51%</i>	22	34	39	54	37	45	50	36	57

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

# Based on average estimated U.S. population statistics for 2005 to 2007.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999 - 2007.

U.S. Census Bureau, Statistical Abstract of the United States: 2009.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Information regarding the CO poisoning victim’s fluency with spoken or written English was seldom represented in reports available to CPSC staff. And, although country of origin does

<sup>7</sup> “Under 5” and “5–14” groups were combined due to small sample sizes.

<sup>8</sup> Ibid.

not necessarily indicate the victim's fluency in English, it may provide some insight into other cultural differences that may influence the usage patterns of carbon monoxide-producing products. For example, individuals who originate from warmer climates, where homes are less airtight, may be less cognizant of the dangers of using fuel-burning products indoors. Table 9 provides a summary of the country of origin for CO fatalities for the years 1999 through 2007. As can be seen in the table, there does not appear to be any evidence that country of origin has an effect on fatalities, with the observed proportion of CO fatalities in each major grouping mirroring the proportion of that group in the U.S. population.

Based on information contained on the death certificates, an estimated 86 percent of CO poisoning victims in 2005 through 2007 were born in the United States (including Puerto Rico), which is equivalent to the U.S.-born population<sup>4</sup> of 88 percent. Nine percent were born in Latin American and Caribbean countries, with 6 percent from Mexico alone. Victims born in Asian countries comprised another 3 percent of CO poisoning victims; 14 of the 19 fatalities, which occurred between 2005 and 2007, were to Asian-born consumers from Vietnam alone. CO poisoning victims born in other countries comprised another 1 percent, as did victims whose country of origin could not be determined.

**Table 9: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Country of Origin, 1999-2007.**

Country of Origin	2005-2007 <sup>+</sup>		Estimated Percentage of US Population <sup>#</sup>	Annual Estimate								
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<i>184</i>	<i>100%</i>	<i>100%</i>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
<b>U.S. Born (including Puerto Rico)</b>	<i>158</i>	<i>86%</i>	<i>88%</i>	<b>91</b>	<b>124</b>	<b>113</b>	<b>166</b>	<b>132</b>	<b>150</b>	<b>170</b>	<b>147</b>	<b>157</b>
<b>Latin America (including Caribbean)</b>	<i>16</i>	<i>9%</i>	<i>7%</i>	<b>9</b>	<b>4</b>	<b>6</b>	<b>7</b>	<b>11</b>	<b>10</b>	<b>13</b>	<b>17</b>	<b>19</b>
Mexico	<i>11</i>	<i>6%</i>		7	1	5	5	8	9	6	11	15
Guatemala	<i>1</i>	<i>1%</i>		*	2	*	1	*	*	*	*	4
Honduras	<i>1</i>	<i>1%</i>		*	*	*	*	*	1	1	3	*
Others	<i>3</i>	<i>2%</i>		2	1	1	1	3	*	6	3	*
<b>Asia</b>	<i>6</i>	<i>3%</i>	<i>3%</i>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>6</b>	<b>2</b>	<b>2</b>	<b>12</b>	<b>5</b>
Vietnam	<i>5</i>	<i>3%</i>		1	*	*	*	2	*	2	8	4
Others	<i>1</i>	<i>1%</i>		2	2	1	4	4	2	*	4	1
<b>Other</b>	<i>2</i>	<i>1%</i>	<i>3%</i>	<b>1</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>1</b>	<b>1</b>
Canada	<i>1</i>	<i>1%</i>		1	*	*	1	1	*	4	*	*
<b>Unknown</b>	<i>1</i>	<i>1%</i>	<i>--</i>	<b>2</b>	<b>3</b>	<b>*</b>	<b>*</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>*</b>	<b>1</b>

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

# Based on average estimated U.S. population statistics for 2005 to 2007.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999-2007.

U.S. Census Bureau, Statistical Abstract of the United States: 2009.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 10 provides a summary of CO fatality victims characterized by race/ethnicity for the years 1999 through 2007. Because of the growing proportion of the U.S. population of Hispanic descent, Hispanic victims were categorized separately, irrespective of their race. It should be noted that estimates of the percentage of the U.S. population categorized into the various race/ethnicity groupings were based on single-race characterizations as represented in the U.S. Census Bureau reports. Multirace population counts were omitted from the calculations. The reason for this modification is death certificates, the primary source of race/ethnicity designations, usually only list a single race/ethnicity designation.

The estimated percentage of the 2005 to 2007 annual average of non-Hispanic white CO fatalities closely mirrors the percentage of the U.S. population<sup>9</sup> at 66 percent and 67 percent, respectively. However, there appears to be a disproportionate number of Black or African American victims of CO poisoning, comprising 18 percent of all CO poisoning fatalities, even though Blacks or African Americans only represent about 12 percent of the U.S. population. By contrast, the proportion of CO poisoning fatality victims who were of Hispanic ethnicity (10 percent) appears well below the percentage of Hispanics in the U.S. population (15 percent). Chi-square goodness-of-fit test results indicate that there is a statistically significant difference (p-value = 0.0253) between the proportion of CO victims categorized by race/ethnicity from that of the general U.S. population. Binomial tests were performed to determine which victim race/ethnicity group proportion was significantly different from the respective proportion in the U.S. population. The tests indicated that one race/ethnicity group was statistically significantly different from the expected proportion based on the U.S. population. The observed proportion of Black or African Americans CO fatalities was significantly higher than the proportion of Black or African Americans in the U.S. population.

**Table 10: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Race/Ethnicity, 1999–2007.**

Country of Origin	2005-2007 <sup>+</sup>		Estimated Percentage of US Population <sup>#</sup>	Annual Estimate								
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>Total</b>	<b>184</b>	<b>100%</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
White (non-Hispanic)	121	66%	67%	57	100	86	135	101	116	137	107	118
Black or African American	34	18%	12%	30	22	19	20	26	27	35	34	33
Hispanic (All races)	19	10%	15%	13	10	9	14	14	20	15	19	24
Asian Pacific	6	3%	4%	6	2	1	4	10	2	2	12	4
American Indian	2	1%	1%	2	2	3	2	2	*	*	6	1
Unknown	2	1%	0%	*	1	1	5	*	2	2	*	3

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

# Based on average estimated U.S. population statistics for 2005 to 2007.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics

Mortality File, 1999 - 2007.

U.S. Census Bureau, Statistical Abstract of the United States: 2009.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 11 provides a breakdown of the CO poisoning fatalities characterized by population density of the incident location. The table is presented as three sections: (1) incidents occurring at all incident locations; (2) incidents occurring in locations identified as a permanent home (e.g., house, apartment, mobile home); and (3) incidents occurring only in non-home locations (e.g., camper trailer, tent, motel room). Please note that “Home Locations” and “Non-Home Locations” sum to “All Locations.”

All fatal incidents were designated as occurring in one of four rural/urban categories based on the Rural-Urban Commuting Area (RUCA) codes developed by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) based on theoretical concepts used by the Office of Management and Budget (OMB) to define county-level metropolitan and micropolitan areas. This 33-category classification system is based on

<sup>9</sup> Average of 2009 U.S. Census Bureau estimates for 2005 through 2007 for the U.S. population.

measures of population density, urbanization, and daily commuting. The OMB methodology is based on county-level delineation. ERS refined the methodology by applying it to smaller census tracts. The WWAMI Rural Health Research Center at the University of Washington<sup>10</sup> further delineated the characterization by cross-referencing each zip code in the United States to its RUCA code classification. The zip code cross-reference was used to characterize each of the CO fatalities into one of four broad categories: Urban, Large Rural, Small Rural, and Isolated.

Table 11 also includes the estimated percentage of the U.S. population per population density designation category. As can be seen in the *All Locations* section, the estimated average percentage of CO fatalities during the three-year period 2005 through 2007 in urban locations (66 percent) is smaller than the percentage of the U.S. population living in urban locations (81 percent). The difference is offset by the larger percentages in small rural locations (9 percent versus 5 percent of the U.S. population) and, especially, isolated locations (14 percent versus 4 percent). A look at the *Non-Home Locations* section helps to explain some of the disparity. An average of 32 percent of all non-home CO fatalities occurred in isolated locations even though the U.S. population living in isolated locations is only 4 percent. In 2005 through 2007, an estimated average 13 of 26 CO poisoning fatalities in isolated locations occurred in non-home locations. Two factors may help to explain the relatively high proportion of isolated location CO fatalities. Many non-home locations where CO fatalities occurred were tents, camper trailers, or cabins in isolated locations used during hunting or camping activities where no local power utility is available. In these cases, individuals may use generators for power and portable LP heaters, lanterns, and stoves for heat. Generators and portable LP heaters, in particular, are associated with large percentages of estimated CO fatalities in isolated temporary shelters (27 of 39, or 69 percent) in the 2005 to 2007 period.

Another possible factor in the elevated percentage of isolated location CO fatalities is the nature of isolation itself. Isolated from friends, family, and neighbors, victims often have little day-to-day interaction with others, so discovery is often days later instead of, perhaps, hours later, which could make the difference between life and death. Isolation may also be a factor when it comes to rescue and hospital services, which may be located very far away.

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<sup>10</sup> The WWAMI name is derived from the first letter of each of the five cooperating states in a partnership between the University of Washington School of Medicine and the states of Wyoming, Alaska, Montana, and Idaho.

**Table 11: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Population Density of Place of Death, 2004-2007.**

RUCA Population Density Designation	2005-2007 <sup>+</sup>		Estimated Percentage of US Population <sup>#</sup>	Annual Estimate								
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007 <sup>+</sup>
<b>All Locations</b>	<b>184</b>	<b>100%</b>	<b>100%</b>	<b>108</b>	<b>137</b>	<b>121</b>	<b>181</b>	<b>153</b>	<b>168</b>	<b>192</b>	<b>178</b>	<b>183</b>
Urban Locations	122	66%	81%	60	81	69	99	107	111	121	122	123
Large Rural	20	11%	10%	7	20	22	24	11	27	22	19	18
Small Rural	17	9%	5%	18	11	15	31	8	13	20	11	20
Isolated	26	14%	4%	22	26	15	28	28	17	29	26	23
<b>Home Locations</b>	<b>143</b>	<b>100%</b>	<b>100%</b>	<b>70</b>	<b>102</b>	<b>93</b>	<b>146</b>	<b>120</b>	<b>132</b>	<b>145</b>	<b>140</b>	<b>145</b>
Urban Locations	100	70%	81%	53	71	53	85	90	91	92	110	99
Large Rural	16	11%	10%	3	16	17	19	11	21	20	14	14
Small Rural	14	10%	5%	8	7	10	27	8	10	18	8	17
Isolated	13	9%	4%	6	8	13	15	11	10	15	8	15
<b>Non-Home Locations</b>	<b>41</b>	<b>100%</b>	<b>100%</b>	<b>36</b>	<b>36</b>	<b>28</b>	<b>35</b>	<b>33</b>	<b>35</b>	<b>47</b>	<b>37</b>	<b>39</b>
Urban Locations	22	54%	81%	7	10	16	14	16	19	30	12	24
Large Rural	3	7%	10%	3	3	5	4	*	5	2	4	4
Small Rural	3	7%	5%	10	4	5	4	*	3	2	3	3
Isolated	13	32%	4%	16	19	2	13	17	8	13	18	8

+ Data collection for 2007 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

\* No reports received by CPSC staff.

# Based on estimated 2006 U.S. population statistics. This is the latest available data for this Density Designation characterization and represents a midpoint value in the 2005 to 2007 range.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, CPSC Injury or Potential Injury Incident File, National Center for Health Statistics Mortality File, 1999–2007.

U.S. Census Bureau, Statistical Abstract of the United States: 2009.

Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

## Appendix A: Methodology

This appendix describes the data sources and methodology used to compute the national estimate of non-fire carbon monoxide (CO) poisoning deaths associated with the use of consumer products and the estimates by product, victim age, and incident location.

All death certificates filed in the United States are compiled by the National Center for Health Statistics (NCHS) into a multiple cause of mortality data file. The NCHS Mortality File contains demographic and geographic information, as well as the International Statistical Classification of Diseases and Related Health Problems codes for the underlying cause of death. Data are compiled in accordance with the World Health Organization instructions, which request that member nations classify causes of death by the current Manual of the International Statistical Classification of Diseases and Related Health Problems. The International Classification of Diseases, Tenth Revision (ICD-10) was implemented in 1999. Although the NCHS data contain cause of death codes that are helpful in identifying deaths due to CO poisoning, the records do not contain any narrative information that might indicate the involvement of a consumer product.

To complement the NCHS mortality data, the CPSC staff purchases death certificates from the 50 states, the District of Columbia, and New York City. Specifically, CPSC staff purchases death certificates with certain cause of death codes for which there is a high probability that consumer products are involved. In addition to the cause of death codes and demographic and geographic information, death certificates contain information about the incident location and a brief narrative describing the incident. Any references to consumer products usually are found in these narratives. CPSC staff conducts follow-up in-depth investigations on selected deaths to confirm and expand upon the involvement of consumer products, as resources allow.

ICD-10 classifies deaths associated with CO poisoning with the codes listed below. The focus of this report is unintentional CO poisoning deaths and concentrates on those deaths coded as X47 and Y17. That is, code X67 records of intentional CO poisonings are excluded from this analysis.

<b>ICD-10 Code</b>	<b>Definition</b>
X47	<b>Accidental</b> Poisoning by and exposure to other gases and vapors. Includes: carbon monoxide, lacrimogenic gas, motor (vehicle) exhaust gas, nitrogen oxides, sulfur dioxide, utility gas.
X67	<b>Intentional</b> Poisoning by and exposure to other gases and vapors. Includes: carbon monoxide, lacrimogenic gas, motor (vehicle) exhaust gas, nitrogen oxides, sulfur dioxide, utility gas.
Y17	<b>Undetermined intent</b> Poisoning by and exposure to other gases and vapors. Includes: carbon monoxide, lacrimogenic gas, motor (vehicle) exhaust gas, nitrogen oxides, sulfur dioxide, utility gas

The first step in compiling the annual estimates is computing the total estimate of CO poisoning deaths associated with consumer products. The CPSC's Death Certificate (DTHS)

File and the CPSC's Abbreviated Death Certificate (ABDT) File were searched for cases associated with ICD-10 codes X47 and Y17.

Each death found in the CPSC's DTHS File and coded X47 or Y17 was reviewed by an analyst and categorized as in-scope, out-of-scope, or unknown or questionable. In-scope cases are unintentional non-fire CO poisoning deaths associated with a consumer product under the jurisdiction of the CPSC. Out-of-scope cases are cases that involve CO sources that are not under the jurisdiction of the CPSC (including motor vehicle exhaust cases), fire or smoke-related exposures, or intentional CO poisonings. Examples of out-of-scope cases include: poisonings due to gases other than CO (i.e., natural gas, ammonia, and butane), motor vehicle exhaust- or boat exhaust-related poisonings, and work-related exposures. The source of CO was classified as unknown or questionable in cases where a consumer product possibly was associated with the incident, but the exact source of CO was unknown.

Deaths found in the CPSC's ABDT File are categorized as out-of-scope cases. The ABDT File contains death certificates for CO poisonings (X47 and Y17) that involve motor vehicle exhaust; cases where the source of the CO is unknown; or incidents in which the death certificate does not mention a consumer product. Other examples of out-of-scope cases that may appear in the abbreviated file are cases associated with farm accidents, smoke inhalation from a structural fire, or other gas poisonings. Occasionally, newer information from CPSC In-Depth Investigations (IDIs) may be matched with ABDT cases that were classified as having no known source or did not mention a consumer product. In the cases where the CPSC IDIs indicate that the CO source was from a consumer product and should be considered in-scope, it was assumed that the death certificate was misclassified, and the subject cases in the ABDT File were included with the DTHS database files.

In previous years, a small number of cases in the ABDT File were identified as in-scope based on further information collected during in-depth investigations. The method used to identify three deaths in 1999 and two deaths in 2000 is found in Appendix A of the 1999 and 2000 Annual Estimate Report (Vagts, 2001). For 2001 data, no ABDT File cases were reclassified as in-scope based on additional information. For the 2002 data, additional information on one incident in the ABDT File resulted in the incident being reclassified as in-scope. This fatality was not included in the NCHS file. Because the incident was not included in the NCHS data, it was also removed from the ABDT File, and thus, was not used in calculations for the weights. For the 2003 data, there were seven reclassified in-scope cases in the ABDT File and five in 2004. For the 2005 data, one case from the ABDT File was reclassified as an in-scope case. For the 2006 data, three cases from the ABDT were reclassified. And for 2007, three more cases were reclassified. The results of the initial categorization for 2007 data are found in Table A.1.

**Table A.1: Initial Categorization for 2007 Data**

ICD-10 Code	NCHS Total	DTHS File				Total in ADBT File	Total in CPSC Databases <sup>1</sup>	Number of Cases to be Imputed <sup>2</sup>
		In-Scope	Unknown Scope	Out-of-Scope	Total			
X47	605	136	8	186	330	135	465	148
Y17	89	2	2	26	30	26	56	35
Total	<b>694</b>	<b>138</b>	<b>10</b>	<b>212</b>	<b>360</b>	<b>161</b>	<b>521</b>	<b>183</b>

1 "Total in ADBT File" cases, plus "Total" from DTHS File.

2 "NCHS Total" cases, minus "Total in CPSC Database," plus "Unknown Scope" from DTHS.

Source: U.S. Consumer Product Safety Commission / EPHA.

CPSC Death Certificate File, CPSC In-Depth Investigation File, Abbreviated Death Certificate File, National Center for Health Statistics Mortality File, 2007.

The proportion of death certificates found in the CPSC database associated with non-fire unintentional X47 or Y17 deaths and associated with consumer products was applied to the NCHS totals to calculate the total estimated number of non-fire CO poisoning deaths associated with consumer products. In theory, the NCHS totals comprise all death certificates in the United States, and the same proportion of in-scope cases should exist in the death certificates that are missing from the combined CPSC Death Certificate and Abbreviated Death Certificate files or are from an unknown source. Applying the proportion of in-scope cases to the NCHS database totals, therefore, should provide an estimate of in-scope cases nationwide. This was done in the following way and was done for ICD-10 codes X47 and Y17 separately:

1. The number of in-scope deaths in the CPSC's Death Certificate File coded X47 or Y17 separately that were associated with an accidental non-fire CO poisoning and a consumer product were identified ( $n_1$ ).
2. The total number of deaths in the CPSC's Death Certificate File and the Abbreviated Death Certificate File coded X47 or Y17 were summed separately, excluding cases with an unknown or highly questionable source ( $n_2$ ).
3. The total number of deaths in the NCHS data associated with X47 and Y17 was counted ( $n_3$ ).
4. The estimate of the number of non-fire CO poisoning deaths associated with consumer products in codes X47 and Y17 was calculated separately using the formula:

$$N = (n_1 / n_2) * n_3$$

The proportion ( $n_1 / n_2$ ) represents the number of in-scope cases found in the CPSC's files, divided by the total of in-scope and out-of-scope cases.

5. The estimates of the number of non-fire CO poisoning deaths associated with consumer products in codes X47 and Y17 were summed to calculate the total estimate of non-fire CO poisoning deaths.

$$\text{Total Estimate} = N_{X47} + N_{Y17}$$

The ratio ( $n_3 / n_2$ ) represents the weighting factor used to calculate the annual estimates. The CPSC's Death Certificate File does not contain death certificates for all deaths listed in the NCHS file; therefore, a weighting factor was calculated to account for those death certificates that are missing. The weighting factor allows the computation of national estimates of CO deaths by consumer products and by other characteristics collected by the CPSC about each death.

Table A.2 contains the values for the variables used in the calculation as well as the final computed 2006 estimate of CO poisoning deaths.

**Table A.2: Calculation Detail of the Final Computed 2007 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products**

Variable	ICD-10 Code	
	X47	Y17
$n_1$	136	2
$n_2$	465-8 = 457	56-2 = 54
$n_3$	605	89
<i>Weighting Factor</i> ( $n_3 / n_2$ )	1.3239	1.6481
N	180.0504	3.2962
<b>Total Estimate</b>	<b>{180.0504 + 3.2962 = 183.3466 ~ 183}</b>	

Source: U.S. Consumer Product Safety Commission / EPHA.  
 CPSC Death Certificate File, CPSC In-Depth Investigation File, Abbreviated Death Certificate File, National Center for Health Statistics Mortality File, 2007.

Table A.3 shows the weighting factors used to calculate the estimates for the years 1999–2007.

**Table A.3: CO Fatality Cases and Weighting Factors Used to Calculate the Estimates for the Years 1999–2007**

Year	NCHS Total	Total in CPSC Databases*	In-Scope Cases <sup>+</sup>	Weighting Factor
<b>1999</b>				
X47	542	469	92	1.1557
Y17	80	66	1	1.2121
<b>2000</b>				
X47	600	551	125	1.0889
Y17	76	70	1	1.0857
<b>2001</b>				
X47	596	520	102	1.1462
Y17	79	62	3	1.2742
<b>2002</b>				
X47	642	599	169	1.0718
Y17	71	61	0	1.1639
<b>2003</b>				
X47	633	625	148	1.0128
Y17	89	75	3	1.1867
<b>2004</b>				
X47	566	527	154	1.0740
Y17	86	72	2	1.1944
<b>2005</b>				
X47	650	590	173	1.1017
Y17	92	70	1	1.3143
<b>2006</b>				
X47	585	527	159	1.1101
Y17	74	53	1	1.3962
<b>2007</b>				
X47	605	457	136	1.3239
Y17	89	54	2	1.6481

+ For some years, the number of In-Scope Cases has changed slightly from the previous report due to either newly obtained information or a recharacterization of a few cases.

\* This is the total number of deaths in the Death Certificate File and Abbreviated Death Certificate File, excluding deaths associated with an unknown or questionable source of CO.

Source: U.S. Consumer Product Safety Commission / EPA.  
CPSC Death Certificate File, CPSC In-Depth Investigation File, Abbreviated Death Certificate File, National Center for Health Statistics Mortality File, 1999–2007.

Incidents with unknown or highly questionable CO sources were excluded from the denominator (the number of fatalities in the CPSC databases) of the weighting factor. The group of cases with unknown or highly questionable sources was assumed to contain the same proportion of cases associated with a consumer product as the group of cases within the CPSC database with known CO sources (this is the same assumption that is made for those cases where the death certificate is missing). To include these cases within the denominator assumes that these cases can be classified as in-scope or out-of-scope, when actually their scope status is unknown. Therefore, for weighting purposes, cases where the source was unknown or highly questionable were treated in the same way as missing cases.

In-scope cases were examined further to determine which product was associated with the incident. Further information on the CO deaths was obtained from a review of the CPSC's In-Depth Investigation File.

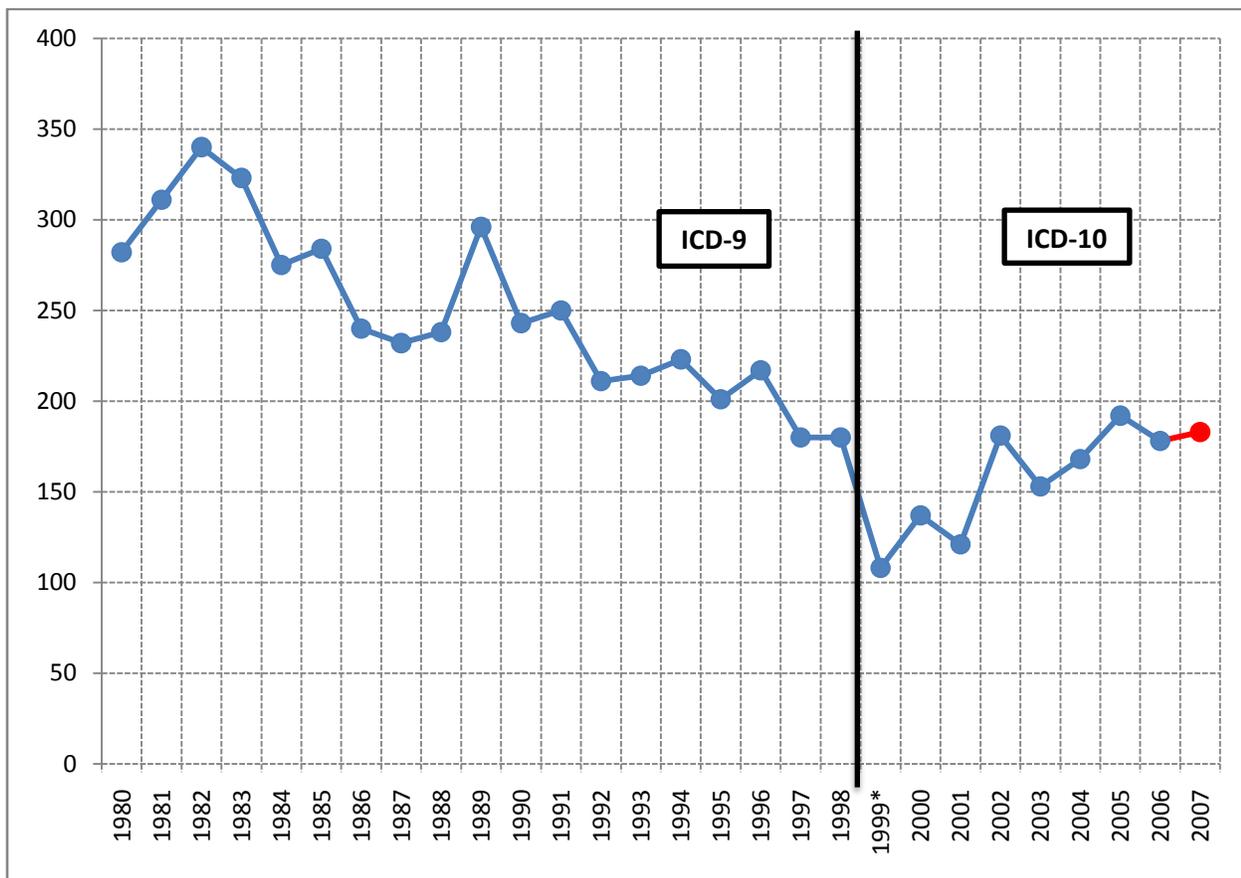
Reports of non-fire CO poisoning deaths were retrieved from the DTHS and ADBT files based on the following criteria: date of death between January 1, 1999 and December 31, 2007, and an ICD-10 code of X47 or Y17. Death certificates entered into the CPSC's database prior to June 10, 2010, were included in this analysis. Each CO death was reviewed and coded by the author, whenever possible, according to the consumer product and type of fuel involved, incident location, and whether multiple deaths resulted in the same incident. If information about the product's condition, venting system, or installation environment was provided in the in-depth investigation report, this information was coded for informational purposes.

In Table 1 of this report, the *Heating Systems* category includes CO poisoning fatalities from subcategories for furnaces and boilers (combined under the heading of *Furnaces*); vented floor and wall heaters; unvented room/space heaters; unvented portable heaters; and other miscellaneous heating systems. Each subcategory is further delineated by fuel type used. Deaths associated with charcoal burned alone and without an appliance (e.g., in a pail or in the sink) were presented with *Charcoal Grills*, even though this practice usually was done for heating purposes. Examples of products historically included in the *Other Products* category include LP gas refrigerators and gas pool heaters. LP gas grills, LP fish cookers, and other LP gas portable cooking appliance incidents are classified in the *Grills, Camp Stoves* category. Deaths where multiple fuel-burning products were used simultaneously such that a single source of the fatal CO could not be determined were classified under *Multiple Products*. *Engine-Driven Tools* included generators and power gardening equipment, such as power lawn mowers; garden tractors; concrete cutters; gasoline-powered water pumps; and snow blowers. Generators that consisted of original equipment installed on a recreational vehicle (RV), trailer, camper, or boat were considered out-of-scope because they are outside the jurisdiction of the CPSC.

## Appendix B: National Estimates of Consumer Product-Related CO Poisoning Deaths, 1980 to 2007

Figure B.1 below graphically suggests a trend of the estimated CO fatalities from 1980 to 2007. Before the implementation of the ICD-10 coding in 1999, the estimated number of non-fire consumer product-related CO poisoning deaths decreased from the early 1980s to the late 1990s from a high of 340 in 1982, to a low of 180 in both 1997 and 1998. In 1999, there were an estimated 108 consumer product-related CO fatalities, well below the estimated 180 deaths in each of the two previous years. The difference may be due, in part, to the change from ICD-9 coding to ICD-10 coding where product identification could be assessed more accurately.

**Figure B.1: Estimated Non-Fire CO Poisoning Deaths Associated with Consumer Products: 1980-2007**



\* Implementation of ICD-10.

Table B.1 presents the annual estimates from 1980 to 2007, and the three-year average mortality rates associated with each year where three years of data were available. The three-year average mortality rate is presented in the table for the midyear point. The estimated three-year average mortality rate decreased from the 1982 high of 14.02 per 10 million population, to a three-year average rate of 7.05 per 10 million in 1997, a reduction of approximately 50 percent. The average mortality rate continued to decrease to a low of 4.32 per 10 million population in 2000. Subsequently, the three-year average rate has been increasing and currently is estimated at

6.18 for the year 2006. The year 2006 is the last year for which data is available to calculate a three-year average.

The Consumer Product Safety Commission established a strategic goal to reduce the CO poisoning mortality rate associated with the use of consumer products by 20 percent from the 1999 through 2000 average rate.<sup>11</sup> The 1999 through 2000 average CO fatality mortality rate was 4.37 per 10 million population. The 2006 average mortality rate was 6.18, an increase of approximately 41 percent.

**Table B.1: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1980–2007**

Year	Estimate	U.S. Population Estimates (thousands)	3-Year Average Mortality Rate per 10 Million Population
1980	282	227,225	
1981	311	229,466	13.55
1982	340	231,664	14.02
1983	323	233,792	13.38
1984	275	235,825	12.47
1985	284	237,924	11.19
1986	240	240,133	10.49
1987	232	242,289	9.77
1988	238	244,499	10.44
1989	296	246,819	10.49
1990	243	249,623	10.53
1991	250	252,981	9.27
1992	211	256,514	8.77
1993	214	259,919	8.31
1994	223	263,126	8.08
1995	201	266,278	8.02
1996	217	269,394	7.40
1997	180	272,647	7.05
1998	180	275,854	5.66
1999*	108	279,040	5.08
2000	137	282,172	4.32
2001	121	285,040	5.13
2002	181	287,727	5.27
2003	153	290,211	5.76
2004	168	292,892	5.84
2005	192	295,561	6.07
2006	178	298,363	6.18
2007	183	301,290	

Note: The three-year average mortality rate is reported at the mid year.

\* The Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) was implemented.

Source: U.S. Consumer Product Safety Commission / EPA.

U.S. Census Bureau, Statistical Abstract of the United States: 2010 (excluding Armed Forces overseas).

<sup>11</sup> U.S. Consumer Product Safety Commission–Strategic Plan, September 2003.

Prior to 1999 with the implementation of ICD-10, it was not possible to generate estimates for an important category of products: generators and other engine-driven tools.<sup>12</sup> With the advent of ICD-10 coding, it is now possible to generate estimates of fatalities associated with generators and other engine-driven tools. This category has been observed to have a statistically significant upward trend in the estimated number of associated CO poisoning fatalities since 1999 (pages 13–14). This increasing trend appears to be having an impact on the mortality rate of consumer product-related CO poisoning fatalities. Table B.2 shows that the 2006 three-year average mortality rate (2.64) for only generators was more than five times greater than the 1999 through 2000 average rate (0.46); and the estimated three-year average rate has increased each year in that time span. In 2005 and 2006, there were more CO fatalities associated with engine-driven tools than with heating systems. These are the only years since the implementation of ICD-10 in which there were more EDT-associated CO deaths than heating system-associated deaths. In 2007, CO fatalities associated with engine-driven tools once again were fewer than with heating systems.

**Table B.2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators, 1999-2007**

Year	Estimate <sup>+</sup>	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	7	279,040	0.46
2000	19	282,172	
2001	20	285,040	0.94
2002	41	287,727	1.27
2003	49	290,211	1.52
2004	42	292,892	2.04
2005	88	295,561	2.41
2006	84	298,363	2.64
2007	64	301,290	

\* Two-year average of 1999 and 2000. The 1999 through 2000 average mortality rate calculation is consistent with the method used to determine the baseline for the strategic goal for the reduction of the CO poisoning mortality rate from all consumer products.

+ Estimates in this table do not include multiple product related deaths because a generator was not the sole product associated with the fatality.

Note 1: The three-year average mortality rate is reported at the mid-year population estimates.

Note 2: Mortality rate changes from last year's report are due to changes in CPSC Co death estimates and changes to U.S. Census estimates.

Table B.3 shows the CO poisoning mortality rates associated with all consumer products, excluding generators. The data indicate that, with the exclusion of generators, there does not appear to be a trend in the mortality rate for consumer products. The 1999 through and 2000 annual average mortality rate was 3.90. The 2006 three-year average mortality rate was 3.54, a decrease of 9 percent. With generators included, the mortality rate increased from 4.37 per 10 million to 6.18 in the same time span, an increase of 41 percent.

<sup>12</sup> See Appendix B of Mah (2001) for details.

**Table B.3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999–2007 (Excluding Generator-Related Deaths)**

Year	Estimate <sup>+</sup>	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	101	279,040	3.90
2000	118	282,172	
2001	101	285,040	4.20
2002	140	287,727	4.00
2003	104	290,211	4.25
2004	126	292,892	3.80
2005	104	295,561	3.65
2006	94	298,363	3.54
2007	119	301,290	

\* Two-year average of 1999 and 2000. The 1999 through 2000 average mortality rate calculation is consistent with the method used to determine the baseline for the strategic goal for the reduction of the CO poisoning mortality rate from all consumer products.

+ Excludes estimates of deaths associated with a generator only.

Note 1: The three-year average mortality rate is reported at the mid-year population estimates.

Note 2: Mortality rate changes from last year's report are due to changes in CPSC CO death estimates and changes to U.S. Census estimates.

Although there were fewer estimated fatalities associated with other engine-driven tools like lawn tractors and power washers in 2007 than in each of the prior five years, the data presented in the body of the report (see Table 3) also indicate that there appears to be an increase in the number of CO poisonings associated with all EDTs. Table B.4 shows the increase in mortality rates of all engine-driven tools, including generators. It can be seen in the table that the average mortality rate has more than quadrupled from the 1999 through 2000 average rate (0.69) to the three-year average for 2005 (3.06).

**Table B.4: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators and Other Engine-Driven Tools, 1999-2007**

Year	Estimate <sup>+</sup>	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	13	279,040	0.69
2000	26	282,172	
2001	22	285,040	1.15
2002	50	287,727	1.48
2003	56	290,211	1.86
2004	56	292,892	2.45
2005	103	295,561	2.94
2006	102	298,363	3.06
2007	69	301,290	

\* Two-year average of 1999 and 2000. The 1999 through 2000 average mortality rate calculation is consistent with the method used to determine the baseline for the strategic goal for the reduction of the CO poisoning mortality rate from all consumer products.

+ Estimates in this table do not include multiple product-related deaths because an EDT was not the sole product associated with the fatality. The one exception to this is the 2001 estimate, which includes one estimated death associated with a generator and another EDT.

Note 1: The three-year average mortality rate is reported at the midyear population estimates.

Note 2: Mortality rate changes from last year's report are due to changes in CPSC CO death estimates and changes to U.S. Census Bureau estimates.

Table B.5 shows the CO mortality rates associated with all consumer products, excluding generators and other engine-driven tools. The data indicate that the annual average mortality rate decreased by 15 percent of non-engine-driven tool consumer products, with the 1999 through 2000 average mortality rate of 3.67 and 3.12 in 2006. The 1999 through 2000 average mortality rate calculation used here is consistent with the method used to determine the baseline for the strategic goal for the reduction of the CO poisoning mortality rate from all consumer products. When all products are included, there has been a 41 percent increase in the CO mortality rate from the baseline rate. Engine-driven tools and generators, in particular, have had a substantial impact on the CO poisoning mortality rate involving consumer products.

**Table B.5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999-2007 (Excluding Generator- and Other Engine-Driven Tool-Related Deaths)**

Year	Estimate <sup>+</sup>	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	95	279,040	3.67
2000	111	282,172	
2001	99	285,040	3.99
2002	131	287,727	3.79
2003	97	290,211	3.90
2004	112	292,892	3.39
2005	89	295,561	3.12
2006	76	298,363	3.12
2007	114	301,290	

\* Two-year average of 1999 and 2000. The 1999 through and 2000 average mortality rate calculation is consistent with the method used to determine the baseline for the strategic goal for the reduction of the CO poisoning mortality rate from all consumer products.

+ Excludes estimates of deaths associated with EDTs only. Multiproduct-associated incidents are included here where an EDT and one or more non-EDT products were involved. The one exception to this is the 2001 estimate, which excludes one estimated death associated with a generator and another EDT.

Note 1: The three-year average mortality rate is reported at the midyear population estimates.

Note 2: Mortality rate changes from last year's report are due to changes in CPSC CO death estimates and changes to U.S. Census Bureau estimates.

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