Non-Fire Carbon Monoxide Deaths
Associated with the Use of Consumer Products
2009 Annual Estimates

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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 2009, and companion statistics since 1999. It should be noted that 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 2009:
- There were an estimated 146 unintentional non-fire CO poisoning deaths associated with consumer products under the CPSC's jurisdiction. The estimated annual average from 2007 to 2009 was 169 deaths.[1]

- *Engine-Driven Tools (EDT)* were associated with the largest percentage of non-fire CO poisoning fatalities at 53 percent (estimated 77 deaths). *Heating Systems*-related CO fatalities were associated with 27 percent (40 deaths), and the remaining six product categories [*Charcoal Grills or Charcoal* (7 deaths), *Ranges, Ovens* (3 deaths)*, Water Heaters* (5 deaths), *Lanterns – LP Fueled* (1 death), *Other Products* (2 deaths), and *Multiple Products* (11 deaths)], combined were associated with a total of 20 percent. In 2009, there were no reported deaths in the *Grills, Camp Stoves* category.

Generators & Other Engine-Driven Tools[2]:
- There were an estimated 79 CO fatalities in 2009 that were associated with *Engine-Driven Tools,* including 2 of the 11 *Multiple Products* deaths in which an EDT and another potential CO-producing product was also in use. Sixty-seven of the 79 EDT-related deaths (including both of the multiple product deaths that involved an EDT) involved generators.

Heating Systems:
- Of the estimated 40 *Heating Systems*-related fatalities in 2009, 85 percent (34 deaths) involved gas heating equipment. Natural gas heating equipment accounted for 33 percent (13 deaths) of all fuel types of heating system-related fatalities; liquefied petroleum (LP or propane) gas heating accounted for 48 percent (19 deaths); and an additional 5 percent (2 deaths) were only identified as unspecified gas heating. Oil- (3 deaths) and wood-fueled (2 deaths) heating systems accounted for a total of 13 percent. Three additional fatalities (8 percent) were associated with heating systems, where the fuel type could not be ascertained from CPSC records.

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[1] 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 products associated with CO poisoning deaths.

[2] 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, 1999–2011*.
http://www.cpsc.gov/library/foia/foia12/os/cogenerators.pdf.

Location/Demographics:

- CPSC staff is aware of 115 fatal non-fire CO incidents involving consumer products in 2009. Seventy-nine percent (91 deaths) of these incidents involved a single fatality.

- Seventy-nine percent (116 deaths) of the estimated 146 CO deaths in 2009 occurred in a home location. Of these 116 estimated fatalities, 7 occurred in an external structure, such as a shed or detached garage, and 1 occurred in a nonfixed location domicile (*e.g.*, camper trailer, boat) used as a permanent home, or a structure not designed for habitation (*e.g.*, sea-land shipping container, metal shed). Additionally, an estimated 12 percent (18 deaths) occurred in tents, camper trailers, and other temporary shelters.

- More CO fatalities occurred in the colder months of the year. In 2009, 58 percent (84 of 146 deaths) occurred during the colder months of November, December, January, and February.

- In the three most recent years of this report (2007–2009), adults 45 years and older comprised an annual average of 59 percent of all non-fire, consumer product-related CO deaths, while this age group makes up about 39 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 2009, 73 percent (an estimated 107 deaths) of CO poisoning victims were males, and 27 percent (39 deaths) were females.

- There is some statistical evidence that the proportion of fatalities by race/ethnicity differs from the proportions of race/ethnicity in the U.S. population in the 2007 through 2009 time frame. The proportion of Hispanic victims (irrespective of race) is significantly lower than the proportion of Hispanic Americans in the U.S. population (9% versus 15%) while the proportion of Black or African American victims was marginally significantly greater of the U.S. population (17% versus 12%) during this time period.

- The proportion of all CO poisoning fatalities that occurred in small towns or isolated rural locations (20 percent in 2007 through 2009) is larger than the proportion of the U.S. population living in these areas (9 percent). The disparity is even higher at isolated non-home locations, which account for 29 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 to 2009, although the short-term trend since 2005 appears to have leveled off, or perhaps, has even been declining.

- The CO poisoning 3-year average mortality rate for 2007 through 2009 associated with consumer products (5.56 per 10 million population) is approximately 28 percent greater than the 3-year average for 2000 (expressed as the midpoint year of the 3-year period 1999 to 2001) of 4.34 per 10 million population. However, for non-engine-driven tool products, the mortality rate has decreased by 20 percent from 3.62 (the 2000 3-year average) down to a 2.91 average mortality rate in 2008 (the average rate for 2007 through 2009). Conversely, the mortality rate of CO poisoning from engine-driven tools during the same time period more than tripled, increasing from 0.72 in 2000, up to a 3-year average of 2.65 for 2008. 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 blood, which in turn, depends upon its concentration in air, the duration of exposure, and an individual's general health. Carbon monoxide combines with the body's 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.[3]

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 that can alert the victim to a potentially hazardous situation. Engine-driven tools powered by gasoline engines 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 wood-chip 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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[3] 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 2009, there were an estimated 146 carbon monoxide (CO) 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 2009. 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 nearly 97 percent of all the fatal CO poisoning deaths that occurred in 2009, in the United States. For the 10 years covered in this report prior to 2009, CPSC records contain approximately 91 percent of all the fatal CO poisoning deaths that occurred in the United States reported to NCHS. Carbon monoxide poisoning deaths referred to in this report do not include those where the CO gas resulted from a fire or a motor vehicle, were intentional in nature, or were directly work-related.

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 user judgment in operating these products can result in fatal scenarios. It should be noted that CPSC staff produces the CO estimates by associated consumer products in order 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 2009 are presented in two formats: by product type (Table 1) and by product within fuel type (Table 2). The data are presented as yearly estimates for each of the 11 years covered by this report and as an average of the most recent 3-year period (2007 through 2009). At the time this report was prepared, data collection was nearly complete for 2009. Estimates for this year may change in the future, if additional data become available. Therefore, they 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 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, 1999–2011."

Table 1 (pages 10−11) 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 were further distributed 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 146 CO poisoning deaths associated with a consumer product that occurred between January 2009 and December 2009, *Heating Systems* were associated with 40 deaths (27% of the total consumer product estimate). Of the 40 deaths associated with heating systems, the majority (85% or 34 fatalities) involved gas heating systems. Among gas heating systems, natural gas heating was associated with an estimated 13 deaths (33% of heating system-related deaths). Liquid Petroleum gas (LP gas)[4] heating was associated with an estimated 19 deaths (48% of heating system-related deaths); and unspecified gas heating was associated with an estimated two deaths (5% of heating system-related deaths). Oil-fueled heating was associated with an estimated three deaths (8% of heating system-related deaths). There were an estimated two deaths (5% of heating system-related deaths) associated with a wood-burning heater. There are no reported kerosene-, coal-, or diesel-fueled heating system fatalities in the 2009 data. Additionally, in 2009, there was an estimated one CO death (3% of heating system-related deaths) associated with heating systems with unknown fuel sources. *Note that the estimates for individual categories may not sum to that of the broader category due to rounding effects.*

Of the estimated 13 deaths in 2009 that were associated with natural gas heating systems, 11 (85%) involved installed furnaces—one (8%) of which was described as being a wall or floor furnace. In addition to the 11 furnace-related deaths, two deaths (15%) were described as being associated with natural gas-fueled room or space heaters. Of the estimated 19 deaths in 2009 that were associated with LP gas heating systems, eight (42%) 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. Unvented portable propane heaters were either camping heaters that used disposable propane tanks, one-pound propane bottles, or tank top heaters that used bulk tanks larger than one pound.

In 2009, an estimated seven CO deaths (5% of the 146 total consumer product estimate) were associated with charcoal or charcoal grills; an estimated five deaths (3%) were associated with water heaters; an estimated 3 deaths (2%) were associated with gas ranges or ovens; an estimated one death (1%) was associated with LP-fueled lanterns; and an estimated 2 deaths were associated with other gas-fueled products. Additionally, in 2009, an estimated 11 deaths were associated with multiple appliances (8% of the total consumer product estimate). The *Multiple Products* category includes all incidents where multiple fuel-burning products were used simultaneously, such that a single source of the CO could not be determined**.**

An estimated 78 CO poisoning deaths (53% of the estimated total for 2009) were associated with the category of *Engine-Driven Tools*, which includes generators, riding mowers or garden tractors, snow blowers/throwers, and other engine-driven equipment. Additionally, 2 of the 11 *Multiple Product* fatalities were associated with some type of engine-driven tool being used in conjunction with another fuel-burning product for an estimated total of 80 CO fatalities associated with the use of an engine-driven tool (55% of the estimated total for 2009). Generator associated deaths comprise the majority of this category. An estimated 67 CO poisoning deaths were associated with a generator, including both of the *Multiple Product* fatalities involving an engine-driven tool in 2009 (84% of all engine-driven tool fatalities and nearly half of the total consumer product estimate).

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[4] In this document, references to liquid petroleum gas, or LP gas, also include propane and butane gases, the two primary components of LP gas.

In recent years, the *Engine-Driven Tools* category has been associated with more CO fatalities than any other category. The estimated number of CO fatalities associated with engine-driven tools (78, not including multiple product incidents) in 2009, is greater than the number associated with heating systems (40 deaths). Since 2005, there have been a far greater number of CO fatalities associated with engine-driven tools than with heating systems. There have been an estimated combined total of 448 engine-driven tool-related CO fatalities from 2005 through 2009, compared to 260 deaths combined for heating systems. From 1999 through 2004, there were twice as many heating system-related CO fatalities (448) than engine-driven tool-related fatalities (224). (Note: These figures exclude fatalities associated with multiple products because these possibly could be categorized into both categories.) Stated differently, while heating system-related CO fatalities have dropped by 30 percent from an approximate estimated average of 75 per year from 1999 through 2004, to an average of 52 per year from 2005 through 2009, the estimated annual average number of engine-driven, tool-related CO fatalities have increased by 140 percent over the same time period, from 37 to 90.

Table 1 (pages 10−11) shows the estimated average annual number of CO poisoning deaths associated with a consumer product for 2007 to 2009. The average yearly total number of CO deaths for this 3-year period is estimated to be 169 (with a standard error of approximately 12.0). The 95 percent confidence interval[5] for this estimated average ranged from 118 to 221 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 2009.

Detailed information regarding the condition of products associated with fatalities was not reliably collected, and the availability of such information in the CPSC's files varied widely. However, information collected often described 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 sometimes blocked 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 mentioned 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 designated not to be turned on until repaired).

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[5] The confidence interval is 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, 1999–2009

Consumer Product	2007–2009+ Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Total	**169**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	*146*
Heating Systems	**55**	**33%**	**50**	**82**	**71**	**93**	**67**	**85**	**47**	**49**	**66**	**58**	*40*
Furnaces	**25**	**15%**	**22**	**37**	**26**	**47**	**29**	**43**	**14**	**30**	**29**	**30**	*16*
Coal	*	*	*	1	1	1	*	1	*	*	*	*	*
Liquid Petroleum (LP) Gas	1	1%	5	7	7	16	3	8	1	9	*	3	*1*
Natural Gas	16	9%	15	25	10	21	19	23	6	19	20	19	*10*
Oil	3	2%	*	4	3	3	1	*	2	*	5	1	*3*
Unspecified Gas	2	1%	1	*	1	1	2	4	2	*	4	2	*1*
Unspecified Fuel	2	1%	1	*	3	4	4	8	3	2	*	5	*1*
Portable Heaters	**13**	**8%**	**16**	**20**	**17**	**26**	**25**	**20**	**23**	**14**	**17**	**13**	*8*
Diesel	*	*	*	*	*	1	*	*	*	*	*	*	*
Kerosene	2	1%	3	3	1	4	5	4	2	3	3	4	*
Liquid Petroleum (LP) Gas	10	6%	12	14	16	20	18	15	19	10	14	9	*8*
Natural Gas	*	*	1	2	*	*	2	*	*	*	*	*	*
Unspecified Gas	*	*	*	*	*	*	*	1	1	*	*	*	*
Unspecified Fuel	*	*	*	*	*	*	*	*	1	1	*	*	*
Wall/Floor Furnaces	**6**	**4%**	**6**	**15**	**18**	**9**	**4**	**6**	**2**	**2**	**9**	**3**	*6*
Liquid Petroleum (LP) Gas	3	2%	3	5	2	4	1	5	*	*	4	1	*5*
Natural Gas	3	2%	2	10	13	4	3	1	2	2	5	2	*1*
Oil	*	*	*	*	1	*	*	*	*	*	*	*	*
Unspecified Fuel	*	*	*	*	2	*	*	*	*	*	*	*	*
Room/Space Heaters	**7**	**4%**	**6**	**9**	**9**	**10**	**8**	**12**	**4**	**1**	**6**	**5**	*9*
Coal	*	*	*	*	3	*	*	1	1	*	*	*	*
Liquid Petroleum (LP) Gas	4	2%	3	1	1	*	1	*	*	*	4	2	*5*
Natural Gas	1	1%	1	7	3	5	3	6	*	1	*	2	*2*
Wood	1	1%	*	1	1	1	2	*	2	*	*	1	*2*
Unspecified Gas	1	1%	1	*	*	3	2	4	1	*	2	*	*
Unspecified Fuel	*	*	*	1	*	*	*	*	3	*	*	*	*
Unspecified Heater/System	**4**	**2%**	*	**1**	*	**2**	*	**3**	**3**	**1**	**5**	**7**	*1*
Liquid Petroleum (LP) Gas	1	1%	*	1	*	*	*	*	*	*	1	2	*
Natural Gas	1	1%	*	*	*	*	*	*	*	*	3	*	*
Unspecified Gas	1	1%	*	*	*	1	*	2	*	*	*	1	*1*
Unspecified Fuel	2	1%	*	*	*	1	*	1	3	1	1	4	*

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Table 1 (continued)

Consumer Product	2007–2009[+]		Annual Estimates										
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[+]
Engine-Driven Tools	**81**	**48%**	**13**	**26**	**21**	**52**	**56**	**56**	**102**	**104**	**79**	**85**	*77*
Generators	70	41%	7	19	20	42	49	41	88	85	68	77	65
Other Engine-Driven Tools	11	7%	6	8	1	10	7	15	13	18	11	8	13
Charcoal Grills, Charcoal	**8**	**5%**	**17**	**8**	**10**	**11**	**8**	**3**	**6**	**10**	**8**	**8**	*7*
Gas Ranges or Ovens	**3**	**1%**	**6**	**12**	**9**	**3**	**3**	**4**	**6**	*****	**6**	*****	*3*
Liquid Petroleum (LP) Gas	< 1	< 1%	3	1	2	*	*	1	1	*	1	*	*
Natural Gas	1	1%	2	5	1	3	*	2	1	*	2	*	1
Unspecified Gas	2	1%	*	5	6	*	3	1	3	*	3	*	2
Gas Water Heaters	**4**	**2%**	**1**	**3**	*****	**1**	**7**	**2**	**6**	**4**	**2**	**6**	*5*
Liquid Petroleum (LP) Gas	1	1%	*	*	*	*	3	1	2	*	1	1	2
Natural Gas	1	1%	*	2	*	1	3	*	*	3	*	1	*1*
Oil	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Unspecified Gas	1	1%	1	1	*	*	1	1	3	1	1	1	*1*
Unspecified Fuel	1	1%	*	*	*	*	*	*	*	*	*	2	*1*
Lanterns - Liquid Petroleum (LP) Gas Fueled	**2**	**1%**	**8**	**3**	*****	**2**	**1**	**3**	**6**	**3**	*****	**4**	*1*
Grills, Camp Stoves	**1**	**1%**	**5**	**1**	**1**	**4**	**1**	**4**	*****	**2**	**2**	*****	*****
Kerosene	*	*	*	*	*	*	*	1	*	*	*	*	*
Liquid Petroleum (LP) Gas	< 1	< 1%	5	1	1	4	1	3	*	1	1	*	*
Unspecified Fuel	< 1	< 1%	*	*	*	*	*	*	*	1	1	*	*
Other Products	**2**	**1%**	**2**	*****	*****	**2**	**2**	**3**	**3**	*****	**2**	**2**	*2*
Chimney – Unspecified Fuel	*	*	*	*	*	*	*	*	1	*	*	*	*
Fireplace – Unspecified Gas	< 1	< 1%	*	*	*	*	*	*	*	*	1	*	*
Fireplace – Wood	< 1	< 1%	*	*	*	2	*	2	*	*	1	*	*
Other Products – Liquid Petroleum (LP) Gas	< 1	< 1%	1	*	*	*	2	*	1	*	*	*	*1*
Other Products – Natural Gas	< 1	< 1%	1	*	*	*	*	*	1	*	*	*	*1*
Unidentified Product	*	*	*	*	*	*	*	1	*	*	*	*	*
Unidentified Product – LP Gas	1	1%	*	*	*	*	*	*	*	*	*	2	*
Multiple Products	**14**	**8%**	**6**	**2**	**8**	**13**	**8**	**7**	**12**	**8**	**20**	**11**	*11*

+　　Data collection for 2009 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, 1999–2009.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 2 (beginning on page 13) organizes the estimates by product within fuel type. The three major fuel types include: *Gas-Fueled Products* (natural gas and liquid petroleum [LP including propane and butane] gas); *Solid-Fueled Products* (charcoal, coal, and wood); and *Liquid-Fueled Products* (gasoline, kerosene, and oil). Of these fuel types, *Liquid-Fueled Products* were associated with 81 of the 146 (55%) estimated CO fatalities in 2009. *Gas-Fueled Products* and *Solid-Fueled Products* were associated with 52 (36%) and 9 (6%) estimated fatalities in the same time period, respectively. An additional two (1%) 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 were also two (1%) fatalities in 2009 associated with consumer products where the fuel type was unknown.

In the *Gas-Fueled Products* category, the majority of CO fatalities in 2009 were associated with heating-related products. Of the estimated 52 gas-fueled appliance fatalities in 2009, 34 (65%) were associated with heating systems or heaters, including furnaces and boilers, portable heaters, wall or floor heaters, room or space heaters, or fireplaces. Additionally, five of the estimated eight fatalities in the *Multiple Gas-Fueled Products* category involved some type of gas heater. Of the estimated 81 liquid-fueled appliance-related fatalities in 2009, 77 (95%) were associated with engine-driven tools (*e.g.*, generators, lawn mowers/garden tractors, power washers). Generators accounted for 65 of the estimated 81 fatalities (80%) in the *Liquid- Fueled Products* category for 2009. Additionally, the estimated one fatality in the *Multiple Liquid-Fueled Products* category also involved a generator.

In 2009, there were an estimated nine fatalities in the *Solid-Fueled Products* category. Seven of these were associated with charcoal or charcoal grills and two with a wood-burning room heater. Additionally, there were an estimated two CO fatalities associated with multiple products of different fuel types— both involved portable LP heaters (gas-fueled), one involved a generator (liquid-fueled), and one involved charcoal (solid-fueled).

Table 2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products Organized by Fuel Type, 1999–2009

Consumer Product	2007–2009+ Average Estimate	2007–2009+ Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Total	**169**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	**146**
Gas-Fueled Products	**62**	**37%**	**72**	**93**	**66**	**92**	**70**	**87**	**53**	**51**	**80**	**55**	**52**
Natural Gas	25	15%	23	51	28	35	30	32	10	26	30	28	16
Furnace	16	9%	15	25	10	21	19	23	6	19	20	19	10
Pool Heater	*	*	1	*	*	*	*	*	1	*	*	*	*
Portable Heater	*	*	1	2	*	*	2	*	*	*	*	*	*
Range/Oven	1	1%	2	5	1	3	*	2	1	*	2	*	1
Room/Space Heater	2	1%	1	7	3	5	3	6	0	1	*	3	2
Wall/Floor Furnace	3	2%	2	10	13	4	3	1	2	2	5	3	1
Water Heater	1	1%	0	2	0	1	3	*	*	3	*	1	1
Unspecified Heater	1	1%	*	*	*	*	*	*	*	*	3	*	*
Other Appliance	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	1
Liquid Petroleum (LP) Gas	**27**	**16%**	**40**	**34**	**30**	**47**	**31**	**37**	**30**	**23**	**26**	**31**	**23**
Furnace	1	1%	5	7	7	16	3	8	1	9	*	3	1
Grill/Camp Stove	< 1	< 1%	5	1	1	4	1	2	*	1	1	*	*
Lantern	2	1%	8	3	*	2	1	4	6	3	*	4	1
Other Products	1	1%	*	*	*	*	1	*	*	*	*	3	1
Portable Heater	10	6%	12	14	16	20	18	15	19	10	14	9	8
Range/Oven	< 1	< 1%	3	1	2	*	*	1	1	*	1	*	*
Refrigerator	*	*	1	*	*	*	1	*	1	*	*	*	*
Room/Space Heater	4	2%	3	1	1	*	1	*	*	*	4	3	5
Unspecified Heater/System	1	1%	*	1	*	*	*	*	*	*	1	3	*
Wall/Floor Furnace	3	2%	3	5	2	4	1	5	*	*	4	1	5
Water Heater	1	1%	*	*	*	*	3	1	2	*	1	1	2
Unspecified Gas	**6**	**4%**	**3**	**7**	**7**	**5**	**8**	**15**	**11**	**1**	**11**	**3**	**5**
Furnace	2	1%	1	*	1	1	2	5	2	*	4	2	1
Portable Heater	*	*	*	*	*	*	*	1	1	*	*	*	*
Range/Oven	2	1%	*	5	6	*	3	1	3	*	3	*	2
Room/Space Heater	1	1%	1	*	*	3	2	4	1	*	2	*	*
Fireplace	< 1	< 1%	*	*	*	*	*	*	*	*	1	*	*
Water Heater	1	1%	1	1	*	*	1	1	3	1	1	1	1
Unspecified Heater	1	1%	*	*	*	1	*	2	*	*	*	1	1
Multiple Gas-Fueled Products	**8**	**5%**	**5**	**1**	**2**	**4**	**1**	**3**	**2**	**1**	**13**	**2**	**8**

Table 2 (continued)

Consumer Product	2007–2009+ Average Estimate	Average Percent	Annual Estimates 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Liquid-Fueled Products	**88**	**52%**	**16**	**35**	**28**	**64**	**66**	**61**	**108**	**108**	**89**	**95**	*81*
Gasoline-Fueled	80	47%	13	26	21	52	56	56	102	104	78	85	77
Generator	70	41%	7	19	20	42	49	41	88	85	68	77	65
Other Engine-Driven Tools	11	7%	6	8	1	10	7	15	13	18	11	8	13
Kerosene-Fueled	**2**	**1%**	**3**	**3**	**1**	**4**	**5**	**5**	**2**	**3**	**3**	**4**	*
Grill/Camp Stove	*	*	*	*	*	*	*	1	*	*	*	*	*
Portable Heater	2	1%	3	3	1	4	5	4	2	3	3	4	*
Oil-Fueled	**3**	**2%**	*	**4**	**5**	**3**	**1**	*	**2**	*	**5**	**2**	*3*
Furnace	3	2%	*	4	3	3	1	*	2	*	5	1	3
Water Heater	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Wall/Floor Furnace	*	*	*	*	1	*	*	*	*	*	*	*	*
Diesel-Fueled	*	*	*	*	*	**1**	*	*	*	*	*	*	*
Portable Heater	*	*	*	*	*	1	*	*	*	*	*	*	*
Multiple Liquid-Fueled Products	**2**	**1%**	*	**1**	**1**	**4**	**4**	*	**2**	**1**	**2**	**4**	*1*
Solid-Fueled Products	**9**	**5%**	**17**	**10**	**16**	**15**	**10**	**8**	**9**	**10**	**9**	**9**	*9*
Charcoal-Fueled	**8**	**5%**	**17**	**8**	**10**	**11**	**8**	**3**	**6**	**10**	**8**	**8**	*7*
Charcoal / Charcoal Grills	8	5%	17	8	10	11	8	3	6	10	8	8	7
Coal-Fueled	*	*	*	**1**	**5**	**1**	*	**2**	**1**	*	*	*	*
Furnace	*	*	*	1	1	1	*	1	*	*	*	*	*
Room/Space Heater	*	*	*	*	3	*	*	1	1	*	*	*	*
Wood-Fueled	**1**	**1%**	*	**1**	**1**	**3**	**2**	**2**	**2**	*	**1**	**1**	*2*
Chimney/Fireplace	< 1	< 1%	*	*	*	2	*	2	*	*	1	*	*
Room/Space Heater	1	1%	*	1	1	1	2	*	2	*	*	1	2

Table 2 (continued)

Consumer Product	2007–2009[+]		Annual Estimates										
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[+]
Unspecified Fuel Products	**5**	**3%**	**1**	**1**	**6**	**5**	**4**	**9**	**12**	**6**	**2**	**11**	**2**
Chimney	*	*	*	*	*	*	*	*	1	*	*	*	*
Furnace	2	1%	1	*	3	4	4	6	3	2	*	5	1
Grill/Camp Stove	< 1	< 1%	*	*	*	*	*	*	*	1	1	*	*
Portable Heater	*	*	*	*	*	*	*	*	1	1	*	*	*
Room/Space Heater	*	*	*	1	*	*	*	*	3	*	*	*	*
Unspecified Heater	2	1%	*	*	*	1	*	1	3	1	1	4	*
Wall/Floor Furnace	*	*	*	*	2	*	*	*	*	*	*	*	*
Unidentified Product	*	*	*	*	*	*	*	1	*	*	*	*	*
Water Heater	1	1%	*	*	*	*	*	*	*	*	*	2	1
Multiple Product - Different Fuels	**4**	**2%**	**1**	*****	**5**	**4**	**4**	**2**	**8**	**6**	**5**	**5**	**2**
Gas & Liquid	3	2%	1	*	5	4	3	2	7	6	5	3	1
Gas & Solid	< 1	< 1%	*	*	*	*	*	*	1	*	*	*	1
Liquid & Solid	< 1	< 1%	*	*	*	*	1	*	*	*	*	1	*
Gas & Liquid & Unspecified	1	1%	*	*	*	*	*	*	*	*	*	2	*

+   Data collection for 2009 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, 1999–2009.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 3 (below) shows a breakdown of the fatality estimates for the 11-year period from 1999 through 2009 in the *Engine-Driven Tools* category. During 2009, engine-driven tools were associated with an estimated 79 carbon monoxide poisoning deaths (54% of the total consumer product estimate). Table 3 totals differ from those in 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 2009, there were two such deaths—both associated with a generator and some other product (in both cases, some type of heater). An estimated 67 of the 79 engine-driven tool-related CO poisoning deaths (85%) were associated with generators, or generators in conjunction with another fuel-burning product. In 2009, the other engine-driven, tool-related CO fatalities included an estimated six deaths that were associated with riding lawn mowers, three with snow blowers, and four were associated with other types of engine-driven products.

Table 3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Engine-Driven Tools, 1999–2009

Engine-Driven Tools	2007-2009[+] Average Estimate	Average Percentage	Annual Estimate										
			1999	2000	2001	2002	2003	2004	2005	2006	2007	2008[+]	2009[+]
Total	**86**	**100%**	**14**	**27**	**27**	**58**	**63**	**59**	**110**	**107**	**85**	**93**	**79**
Generators	**70**	**81%**	**7**	**19**	**20**	**41**	**50**	**41**	**88**	**85**	**68**	**77**	**65**
Other Engine-Driven Tools (OEDTs)	**10**	**12%**	**6**	**8**	**1**	**10**	**7**	**15**	**13**	**18**	**11**	**6**	**13**
Lawn Mowers	**4**	**5%**	**6**	**7**	**1**	**5**	**6**	**8**	**9**	**11**	**5**	**2**	**6**
Riding Mowers	4	5%	6	5	1	5	6	5	9	8	4	2	6
Walk Behind Mowers	*	*	*	1	*	*	*	1	*	*	*	*	*
Unspecified Mowers	< 1	< 1%	*	*	*	*	*	1	*	3	1	*	*
Power Washer	1	1%	*	*	*	*	*	2	3	1	1	*	1
Snow Blower / Thrower	2	2%	*	1	*	*	*	1	*	1	2	*	3
ATV	1	1%	*	*	*	1	*	1	1	*	*	2	*
Water Pump	< 1	< 1%	*	*	*	*	*	1	*	1	1	*	*
Welder	1	1%	*	*	*	2	1	*	*	*	1	1	*
Air Compressor	*	*	*	*	*	*	*	1	*	1	*	*	*
Concrete Saw	< 1	< 1%	*	*	*	1	*	1	*	*	*	1	*
Tiller	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	1
Go-Cart	1	1%	*	*	*	*	*	*	*	*	*	*	2
Small Engine	*	*	*	*	*	*	*	*	*	1	*	*	*
Snowmobile	*	*	*	*	*	*	*	*	*	1	*	*	*
Multiple Product: Engine-Driven Tools Involved	**6**	**7%**	**1**	**1**	**6**	**8**	**6**	**3**	**9**	**3**	**6**	**9**	**2**
Generator + OEDT	*	*	*	*	1	*	*	*	*	*	*	*	*
Generator + other Product	5	6%	*	1	5	6	5	2	9	3	6	8	2
Multiple OEDT	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
OEDT + other product	*	*	1	*	*	1	1	1	*	*	*	*	*

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.
* No reports received by CPSC staff.
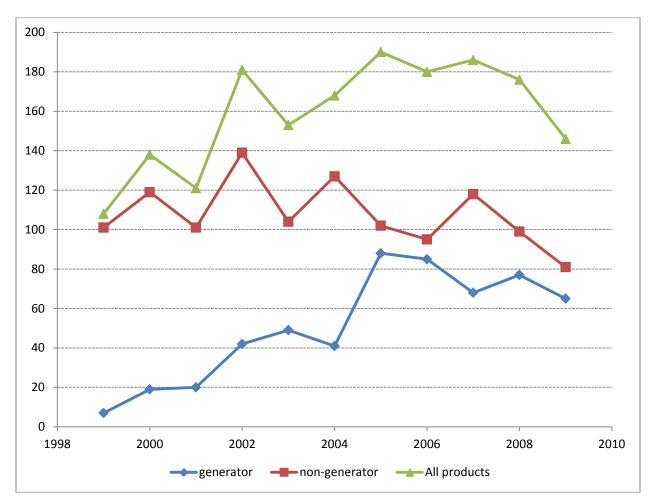Source: U.S. Consumer Product Safety Commission/EPHA.
    CPSC Death Certificate File, CPSC Injury or Potential Injury Incident File, CPSC In-Depth Investigation File,
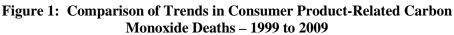   National Center for Health Statistics Mortality File, 1999–2009.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

In 2009, there were an estimated 77 CO fatalities associated with engine-driven tools (79, if the two multiproduct incidents involving an engine-driven tool are included). As can be seen in Table 3, the estimated numbers of fatalities associated with engine-driven tools increased dramatically in 2005 and 2006, over previous years. The large increase in the number of engine-driven tool fatalities in 2005 can partially be explained by the large increase of generator-related deaths associated with severe weather events. An unusually severe hurricane season and ice storms in the South and the Midwest caused widespread power outages, prompting consumers to resort to the use of generators, often unsafely, as an alternative source of power. It is unclear why the number of generator fatalities remained high in 2006, which was a relatively mild weather event year. From 2007 through 2009, there were an estimated average of 86 CO fatalities associated with engine-driven tools, slightly lower than the peak 2005/2006 levels (an estimated of 109), but still in excess of the pre-2005/2006 levels.

Figure 1 provides a graphic representation of the CO fatality trends related to: (1) all consumer products; (2) to engine-driven tools alone, and (3) to non-engine-driven tools. A regression analysis of the estimated number of all non-fire, consumer product-related CO poisoning fatalities from 1999 to 2009, indicates that there is statistical evidence of an upward trend in the data (p-value = 0.0376), even though the short-term trend since 2005 appears to have leveled off, or perhaps, has even been declining. It should be pointed out that due to reporting delays, national estimates for recent years, especially 2009, most likely will change in subsequent reports. As can be seen in the figure, the estimated number of non-generator CO fatalities fluctuates from year-to-year, but appears to be fairly steady though in 2009, when there were fewer non-generator CO fatalities than any other year of this report. Conversely, the estimated number of generator CO fatalities has shown a steady rise, to peak levels in 2005 and 2006. The estimated number of generator CO fatalities in 2007 through 2009 are below the peak 2005 and 2006 levels, but greater than the years prior to 2005.

**Figure 1: Comparison of Trends in Consumer Product-Related Carbon
Monoxide Deaths – 1999 to 2009**

Lawnmowers were associated with 61 percent (66 of 108) of the deaths in the *Other
Engine-Driven Tools* category for the 11-year period. There were two other fatalities associated
with a lawnmower and another product in this time period—one with a generator, and the other
with a propane heater. There was an estimated average of four lawnmower-related CO fatalities
per year in 2007 to 2009 (13 deaths). CO fatalities related to snow blower/thrower usage were in
the next largest subcategory, with an estimated eight deaths from 1999 to 2009, and five
occurred from 2007 through 2009.

Table 4 shows that in 2009, 79 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 also to
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 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 are based on CPSC 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. Over the 11-year period covered by this report, CPSC records indicate that 19 percent (247 of 1,304 incidents) resulted in multiple fatalities, including 15 incidents resulting in four or more CO fatalities.

Table 4: Number of Carbon Monoxide Poisoning Incidents Reported to CPSC by Number of Deaths Per Incident, 1999–2009

Number of Deaths Reported in Incident	2007−2009[+]		Annual Incidents										
	Annual Average	Average Percent	1999	2000	2001	2002	2003	2004	2005[#]	2006	2007	*2008*	*2009[+]*
Total Incidents	133	100%	78	104	88	130	121	127	146	123	147	139	*115*
1	109	82%	63	82	71	101	96	105	123	93	125	118	*91*
2	16	12%	14	19	15	24	21	14	17	22	13	15	*19*
3	6	5%	*	2	2	1	3	7	5	6	8	4	*4*
4	1	1%	1	*	*	2	*	1	*	1	1	2	*1*
5	< 1	< 1%	*	*	*	2	1	*	*	1	*	*	*
6	*	*	*	1	*	*	*	*	1	*	*	*	*

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

* No incident reports received by CPSC staff were 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 non-worker). 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, 1999–2009.

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 CPSC may not have a death certificate.

Table 5 shows that in 2009, an estimated 116 CO poisoning deaths occurred in home locations, including an estimated eight deaths in detached structures at residential locations (*i.e.*, sheds, detached garages) and structures not intended originally as a permanent residence (*i.e.*, camper trailers, sea-land shipping containers). From 2007 to 2009, an annual average of 138 CO poisoning deaths (82% of all CO fatalities) occurred at home locations. In 2009, an estimated 18 deaths took place in temporary shelters, such as tents, ice fishing sheds, and boats. For 2007 to 2009, an annual average of 19 CO poisoning deaths (11%) took place in temporary shelters. In 2009, CO deaths in temporary shelters were most commonly associated with heating sources, generators, or lanterns. An estimated 8 of 18 (44%) CO deaths in temporary shelters were associated with LP-fueled products, including portable heaters and water heaters. In 2009, an estimated eight deaths (44%) 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 2009, there were an estimated 13 (9%) CO fatalities in this category— most commonly associated with generators (6 deaths), portable LP heaters (3 deaths), and charcoal grills (3 deaths). For 2007 to 2009, an annual average of 10 CO poisoning deaths (6%) took place in vehicles.

Table 5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Location of Death, 1999−2009

Location of Death	2007−2009[+]		Annual Estimate										
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[+]
Total	**169**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	*176*	*146*
Home[1]	124	73%	58	87	78	121	109	121	120	119	138	126	*108*
Home – External Structure[2]	10	6%	7	8	8	15	11	10	16	14	11	13	*7*
Home – But Not House[3]	4	2%	6	5	5	8	2	*	6	4	4	6	*1*
Temporary Shelter	19	11%	28	32	17	32	22	22	32	36	22	16	*18*
Vehicles (including boats)	10	6%	9	7	13	4	9	8	14	6	8	9	*13*
Other	2	1%	*	*	*	*	*	8	2	1	2	3	**
Unknown	1	1%	*	*	*	*	2	*	*	*	*	2	**

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

* No reports received by CPSC staff.

1 Traditional home (*e.g.,* detached house, townhouse, apartment, mobile home)

2 External structure at residential locations (*e.g.,* detached garage, shed)

3 Non-fixed structure or structure not originally designed for permanent occupation (*e.g.,* camper trailer, van, converted sea-land shipping)

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, 1999–2009.

CPSC data indicate that there were more CO fatalities attributable to incidents that occurred in the colder months than in the warmer months. This is most likely because of the use of furnaces and portable heaters in the colder months. Additionally, generators are often used in the winter months because of power outages due to snow and ice storms. Table 6 on the next page shows the annual estimated CO fatalities categorized by month of death for the 11 years covered by this report. In 2009, 84 of the 146 estimated CO fatalities (58%) are attributable to incidents that occurred during the colder months of November, December, January, and February. An estimated 42 fatalities (29%) are attributable to incidents that occurred during the transition months of March, April, September, and October; and an estimated 21 fatalities (14%) in the warmer months of May, June, July, and August. Over the 11 years this report spans, an estimated 59 percent of CO fatalities are attributable to incidents that occurred during the colder months; an estimated 25 percent are attributable to incidents that occurred during the transition months; and an estimated 16 percent of fatalities occurred in the warmer months.

Table 6: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Month and Year of the Fatality, 1999–2009

Month of Death	2007−2009+		Annual Estimate										
	Average Estimate	Average Percent	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Total	**169**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	*146*
Cold Months	**100**	**59%**	**59**	**89**	**86**	**94**	**96**	**107**	**98**	**95**	**109**	**107**	*84*
November	20	12%	7	28	13	27	32	26	18	23	21	28	*12*
December	22	13%	16	33	24	26	30	27	33	38	25	22	*19*
January	34	20%	28	17	26	20	22	34	37	14	43	31	*29*
February	23	14%	8	11	23	21	12	20	10	20	20	26	*24*
Transition Months	**42**	**25%**	**31**	**31**	**28**	**67**	**39**	**41**	**62**	**56**	**49**	**36**	*42*
March	13	8%	17	9	3	28	8	10	19	19	19	7	*13*
April	10	6%	2	3	13	9	13	8	9	16	15	8	*8*
September	4	2%	6	7	5	5	9	14	17	7	1	7	*4*
October	15	9%	6	12	7	25	9	9	17	14	14	14	*17*
Warm Months	**27**	**16%**	**18**	**18**	**7**	**19**	**19**	**19**	**31**	**29**	**29**	**32**	*21*
May	10	6%	3	7	5	4	3	5	4	9	9	17	*5*
June	7	4%	5	3	*	5	7	6	9	3	4	7	*10*
July	4	2%	5	5	*	2	6	4	12	4	5	3	*4*
August	6	4%	5	3	2	8	3	4	6	13	11	5	*2*

+ Data collection for 2009 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– 2009.

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 estimated number of CO poisoning fatalities. The total estimated number of CO poisoning fatalities is presented on the radar graph by month of death. The shaded area represents the estimated total number of fatalities for 1999 through 2009, for each month. It can be seen clearly that more CO deaths occur in the colder months, particularly, November, December, and January, than in warmer months. It also can be seen that as the months after the summer get colder, the number of CO fatalities increases. Conversely, as the months after the winter get warmer, the number of fatalities decreases.
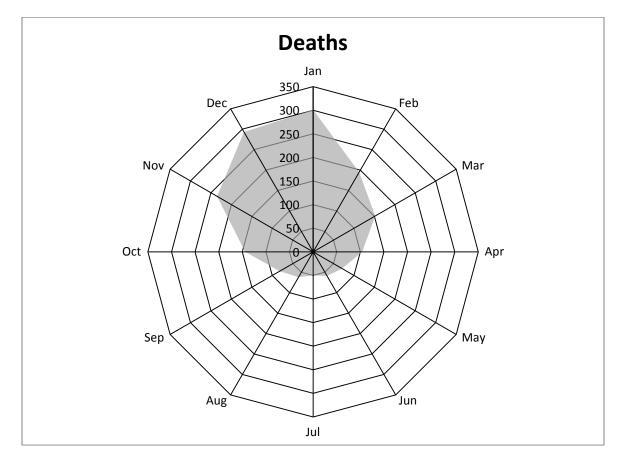
Figure 2: Estimated Number of Consumer Product-Related Carbon Monoxide Deaths by Month of Death, 1999–2009

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 11 most recent years of data (1999–2009). From the summary, it appears that consumer product-related CO fatalities are skewed toward older individuals. For the three most recent years (2007–2009), children younger than 15 years of age accounted for an annual average of 5 percent (an estimated 9 of 169) of the yearly CO poisoning deaths, while this age group represents an average of about 20 percent of the U.S. population. The annual average percentage of deaths represented by adults 45 years and older was 59 percent (99 of 169) in 2007 to 2009, while only about 37 percent of the U.S. population is over 45 years old. In 2007 to 2009, adults age 65 years and older accounted for an annual average percentage of 20 percent of CO poisoning fatalities, although this age group is about 13 percent of the U.S. population.[6] Chi-square goodness-of-fit test results indicate that there is a statistically significant difference (p-value = < 0.0001) between the proportion of CO victims in each age group from that of the general U.S. population. Each age group was analyzed separately, versus the expected proportion of the respective age group, based on U.S. population figures, assuming there was no age group effect on the CO poisoning fatality rate, to determine which age group proportions were significantly different from expectation. Binomial tests indicate that three groups were found to be significantly different than what would be expected if there was no population group effect:

1. The "Under 15" group[7] was significantly lower;
2. The "45–64" group was significantly higher; and
3. The "65 and older" group was significantly higher.

Table 7: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Age of Victim, 1999–2009

Age	2007–2009[+]		Estimated Percentage of U.S. Population[#]	Annual Estimate										
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	*2009[+]*
Total	**169**	**100%**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	***146***
Under 5	4	2%	7%	*	3	3	2	6	3	*	2	8	2	*3*
5 - 14	5	3%	13%	7	3	6	9	9	11	7	4	6	8	*2*
15 - 24	16	9%	14%	8	10	16	11	17	4	17	21	18	16	*14*
25 - 44	44	26%	27%	31	42	23	56	46	43	46	59	34	55	*43*
45 - 64	65	38%	26%	45	57	39	51	55	68	86	58	70	66	*59*
65 and over	34	20%	13%	16	23	33	51	21	39	34	36	49	29	*25*

+ Data collection for 2009 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 2007 to 2009.

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 - 2009.
   U.S. Census Bureau, Statistical Abstract of the United States: 2012.

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

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[6] U.S. Census Bureau, Statistical Abstract of the United States: 2010.

[7] "Under 5" and "5–14" groups were combined due to small sample sizes.

Table 8 presents the distribution of estimated CO fatalities categorized by gender. In 2009, 73 percent of CO poisoning victims were males, and 27 percent were females. These percentages varied slightly from year to year over the 11 years of this report, but every year there are many more male CO fatalities than female ones. Over the years, 1999 through 2009, the average percentage of male CO victims was 75 percent, and the average percentage of female victims was 25 percent. By contrast, about 49 percent of the U.S. population is male, and 51 percent are female[8]. Chi-square goodness-of-fit test results indicate that there is a statistically significant difference (p-value = < 0.0001) between the proportion of CO victims by gender group and that of the general U.S. population.

Table 8: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Gender of Victim, 1999-2009

Gender	2007−2009+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Total	169	100%	100%	108	138	121	181	153	168	190	180	186	176	146
Male	127	75%	49%	86	105	82	126	118	123	140	145	132	142	107
Female	42	25%	51%	22	34	39	54	37	45	50	36	53	34	39

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.
# Based on average estimated U.S. population statistics for 2007 to 2009.
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, 1999–2009.
          U.S. Census Bureau, Statistical Abstract of the United States: 2012.
     Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 9 provides a summary of CO fatality victims characterized by race/ethnicity for the years 1999 through 2009. 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 because death certificates, the primary source of race/ethnicity designations, often list only a single race/ethnicity designation.

The estimated percentage of the 2007–2009 annual average of non-Hispanic white CO fatalities closely mirrors the percentage of the U.S. population[9] at 67 percent and 66 percent, respectively. However, there appears to be a disproportionate number of Black or African American victims of CO poisoning, comprising 17 percent of all CO poisoning fatalities, even though Blacks or African Americans represent only about 12 percent of the U.S. population. By contrast, the proportion of the CO poisoning fatality victims who were of Hispanic ethnicity (9%) is below the percentage of Hispanics in the U.S. population (15%). Chi-square goodness-of-fit test results indicate that there is a marginally non-significant statistical difference (p-value = 0.0898) between the proportion of CO victims categorized by race/ethnicity from that of the general U.S. population. Each race/ethnicity group was analyzed separately, versus the expected proportion of the respective race/ethnicity group based on U.S. population figures, assuming

[8] Average of 2012 U.S. Census estimates for 2007 through 2009 for the U.S. population.
[9] The "percentage of the U.S. population" is defined here as the average of the 2012 U.S. Census estimates for 2007 through 2009 for the U.S. population.

there was no race/ethnicity group effect on the CO poisoning fatality rate, to determine which race/ethnicity group proportions were significantly greater than or less than the expectation. Binomial tests indicate that one race/ethnicity group was statistically significantly different from the expected proportion based on the U.S. population. The observed proportion of Hispanic CO fatalities was significantly lower (p-value < 0.05) than the proportion of Hispanics in the U.S. population. Additionally, the observed proportion of Black or African American CO fatalities was marginally significantly higher (p-value < 0.10) than the proportion of Black or African Americans in the U.S. population.

Table 9: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Race/Ethnicity, 1999−2009

Country of Origin	2007−2009[+]		Estimated Percentage of U.S. Population[#]	Annual Estimate										
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[+]
Total	**169**	**100%**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	*146*
White (non-Hispanic)	113	67%	66%	57	101	86	138	102	116	134	107	122	123	*93*
Black or African American	28	17%	12%	30	22	19	20	26	27	36	36	35	30	*20*
Hispanic (All races)	16	9%	15%	13	10	9	14	14	20	15	19	23	15	*11*
Asian / Pacific	2	1%	5%	6	2	1	4	10	2	2	13	3	1	*3*
American Indian	1	1%	1%	2	2	3	2	2	0	0	6	1	2	*1*
Unknown / Other	8	5%	1%	0	1	1	1	0	2	2	0	2	4	*19*

+ Data collection for 2009 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 2007 to 2009.
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, 1999–2009.
    U.S. Census Bureau, Statistical Abstract of the United States: 2012.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 10 provides a breakout 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). The categories are based on theoretical concepts used by the U.S. Office of Management and Budget (OMB) to define county-level metropolitan and micropolitan areas. This 33-category classification system is based on measures of population density, urbanization, and daily commuting. The OMB methodology is based on a 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[10] 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

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10 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.

characterize each of the CO fatalities into one of four broad categories: Urban Core, Sub-Urban, Large Rural Town, and Small Town/Rural Isolated.

Table 10 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 3-year period 2007 through 2009, in urban locations (55%), is smaller than the percentage of the U.S. population living in urban core locations (71%). The difference is offset by the larger percentages the other three categories: sub-urban locations (12% versus 10% of the U.S. population), large rural town locations (14% versus 10%), and small town/rural isolated locations (20% versus 9%). A look at the *Non-Home Locations* section helps to identify some of the disparity. An average of 29 percent of all non-home CO fatalities occurred in small town/rural isolated locations, even though the U.S. population living in isolated locations is only 9 percent. In 2007 through 2009, an estimated average of 9 of 33 CO poisoning fatalities in small town/rural isolated locations occurred in non-home locations. Two factors may help to explain the relatively high proportion of small town/isolated rural 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 often resort to generators for power and use portable LP heaters, lanterns, and stoves.

Another possible factor in the elevated percentage of small town/isolated rural location CO fatalities is the isolated nature itself. Being 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, which could make the difference between life and death. Small towns or isolated rural location may also be a factor when it comes to rescue and hospital services, which may be very far away.

Table 10: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Population Density of Place of Death, 1999–2009

RUCA Population Density Designation	2007−2009+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
All Locations	**169**	**100%**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	**146**
Urban Core	93	55%	71%	60	83	68	100	110	112	119	122	110	96	72
Sub-Urban	21	12%	10%	7	20	22	24	11	27	21	22	19	20	23
Large Rural Town	23	14%	10%	20	11	16	31	8	14	20	12	18	37	13
Small Town / Rural Isolated	33	20%	9%	22	25	15	26	25	15	30	23	39	23	38
Home Locations	**138**	**100%**	**100%**	**70**	**101**	**90**	**144**	**121**	**131**	**141**	**139**	**153**	**145**	**116**
Urban Core	78	57%	71%	53	70	52	86	92	91	89	107	93	81	61
Sub-Urban	17	12%	10%	3	16	17	19	11	21	19	16	16	18	16
Large Rural Town	19	14%	10%	8	7	11	27	8	10	18	8	16	28	13
Small Town / Rural Isolated	24	17%	9%	6	8	10	12	10	9	15	8	28	18	26
Non-Home Locations	**31**	**100%**	**100%**	**37**	**37**	**31**	**36**	**32**	**36**	**48**	**43**	**32**	**30**	**31**
Urban Core	15	47%	71%	7	13	16	14	17	20	30	16	17	15	12
Sub-Urban	4	13%	10%	3	3	5	4	*	5	2	7	3	2	7
Large Rural Town	3	11%	10%	12	4	5	4	*	4	2	4	2	8	*
Small Town / Rural Isolated	9	29%	9%	15	17	5	14	15	7	14	16	10	5	12

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

* No reports received by CPSC staff.

\# Estimated 2010 U.S. population categorized by RUCA designation. U.S. population estimates by RUCA classification were determined from by cross-referencing the WWAMI RUCA zip code table with the 2010 U.S. Census population estimates by zip code area, the most current census data available by zip code area.

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, 1999–2009.
　　　　U.S. Census Bureau, Statistical Abstract of the United States: 2010.

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

Table 11 provides a breakout of the CO poisoning fatalities characterized by geographic region where the incident occurred. As can be seen in the table, for the most part, the percentage of CO fatalities in each of the regions reflects the percentage of the U.S. population living in these regions. This would indicate that geographic location has little effect on the likelihood of fatal CO poisoning incidents. There are, however, a few exceptions that should be pointed out. The Midwest region, as a whole, exhibited a far greater than expected number of CO deaths. Thirty percent of the estimated CO fatalities in 2007 through 2009 occurred in Midwest states where only 22 percent of the U.S. population live. The Mountain states of the West region also had a greater than expected number of CO deaths compromising 11 percent of the deaths, yet home to only seven percent of the population. Conversely, the South Atlantic states of the South region accounted for 12 percent of the CO deaths where 19 percent of the U.S. population live. The Pacific states of the West region also accounted for fewer CO deaths than expected (9% of the deaths, 16% of the population).

Table 11: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Geographical Region of Incident, 1999–2009

Region‡	2007–2009+		Estimated Percentage of US Population#	Annual Estimates										
	Average Estimate	Average Percent		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009+
Total	**169**	**100%**	**100%**	**108**	**138**	**121**	**181**	**153**	**168**	**190**	**180**	**186**	**176**	*146*
North East	**28**	**17%**	**18%**	**12**	**20**	**11**	**18**	**24**	**16**	**33**	**24**	**44**	**27**	*12*
New England	9	5%	5%	1	1	1	6	3	7	7	8	10	11	*5*
Middle Atlantic	19	11%	13%	10	19	10	12	21	10	26	16	34	16	*7*
South	**56**	**33%**	**37%**	**37**	**49**	**38**	**69**	**53**	**58**	**74**	**57**	**61**	**52**	*55*
South Atlantic	20	12%	19%	28	17	11	38	25	21	41	26	25	21	*13*
East South Central	13	8%	6%	3	8	6	12	15	16	9	10	9	10	*19*
West South Central	24	14%	12%	6	24	21	19	12	21	24	21	27	21	*23*
Midwest	**51**	**30%**	**22%**	**28**	**46**	**28**	**58**	**41**	**49**	**46**	**54**	**47**	**59**	*48*
East North Central	31	18%	15%	17	37	14	38	34	30	31	40	25	40	*28*
West North Central	20	12%	7%	10	9	14	20	7	19	15	14	22	19	*20*
West	**34**	**20%**	**23%**	**31**	**24**	**44**	**33**	**33**	**37**	**33**	**46**	**33**	**37**	*31*
Mountain	19	11%	7%	20	17	24	21	12	20	18	21	17	22	*17*
Pacific	16	9%	16%	12	7	20	12	20	16	15	24	17	16	*15*

‡ Region designation is based on U.S. Census Bureau reporting practices. See Appendix C for identification of specific regional designation of state of occurrence.

+ Data collection for 2009 is nearly complete. Italicized estimates may change in the future if more reports of fatalities are received.

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 2006 to 2008 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, 1999–2009.
     U.S. Census Bureau, Statistical Abstract of the United States: 2010.

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, 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, the death certificate contains information about the incident location and a brief narrative describing the incident. Any references to consumer products are usually found in these narratives. As resources allow, CPSC staff conducts follow-up In-Depth Investigations on selected deaths to confirm and expand upon the involvement of consumer products.

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 deaths coded as X47 and Y17. That is, code X67—records of intentional CO poisonings—are excluded from this analysis.

ICD-10 Code	**Definition**
X47	**Accidental**– 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	**Intentional**– 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	**Undetermined intent**– 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 estimates 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 as X47 or Y17 was reviewed by an analyst and categorized as in scope, out of scope, or whether the source of the CO was 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, 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 was possibly 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 where 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 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 IDIs. 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, it 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. For 2008 and 2009, no ABDT records were reclassified as in-scope.

Since the release of the previous annual report, additional records have been entered into the CPSC databases, and therefore, the resultant initial categorization for 2007 through 2009 has been recalculated and is presented in Tables A.1.a through A.1.c.

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

ICD-10 Code	NCHS Total	DTHS File				Total in ABDT File	Total in CPSC Databases[1]	Number of Cases to be Imputed[2]
		In-Scope	Unknown Scope	Out-of-Scope	Total			
X47	605	173	10	235	418	172	590	25
Y17	89	4	4	34	42	30	72	21
Total	**694**	**177**	**14**	**269**	**460**	**202**	**662**	**46**

Table A.1.b: Initial Categorization for 2008 Data

ICD-10 Code	NCHS Total	DTHS File				Total in ABDT File	Total in CPSC Databases[1]	Number of Cases to be Imputed[2]
		In-Scope	Unknown Scope	Out-of-Scope	Total			
X47	677	161	22	198	381	290	671	28
Y17	68	6	6	22	34	25	59	15
Total	**745**	**167**	**28**	**220**	**415**	**315**	**730**	**43**

Table A.1.c: Initial Categorization for 2009 Data

ICD-10 Code	NCHS Total	DTHS File				Total in ABDT File	Total in CPSC Databases[1]	Number of Cases to be Imputed[2]
		In-Scope	Unknown Scope	Out-of-Scope	Total			
X47	734	143	16	230	389	361	750	0
Y17	72	2	5	23	30	22	52	25
Total	**806**	**145**	**21**	**253**	**419**	**383**	**802**	**25**

1 "Total in ABDT 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, 2007–2009.

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 as 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 as 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 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 CPSC about each death.

Table A.2 contains the values for the variables used in the calculation, as well as the final computed 2008 estimate of CO poisoning deaths.

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

	ICD-10 Code	
Variable	**X47**	**Y17**
n_1	173	4
n_2	590-10 = 580	72-4 = 68
n_3	605	89
Weighting Factor (n_3 / n_2)	1.0431	1.3088
N	180.4569	5.2353
Total Estimate	{180.4569 + 5.2353 = 185.6922 ~ 186}	

Table A.2.b: Calculation Detail of the Final Computed 2008 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
n_1	161	6
n_2	671-22 = 649	59-6 = 53
n_3	677	68
Weighting Factor (n_3 / n_2)	1.0431	1.283
N	167.9461	7.6981
Total Estimate	{167.9461 + 7.6981 = 175.6442 ~ 176}	

Table A.2.c: Calculation Detail of the Final Computed 2009 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
n_1	143	2
n_2	750-16 = 734	52-5 = 47
n_3	734	72
Weighting Factor (n_3 / n_2)	1	1.5319
N	143.0000	3.0638
Total Estimate	{143 + 3.0638 = 146.0638 ~ 146}	

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, 2008.

It should be noted that death certificates received by NCHS are routinely checked for accuracy of state personnel identified ICD-10 coding. On occasion, NCHS staff will correct codes before entering the data into their databases. The death certificate facsimiles or electronic death certificates that CPSC receives are direct from the states, and therefore, have not been corrected per NCHS procedures. As a consequence, there may be slight discrepancies between final NCHS counts and CPSC records, which are not due to CPSC simply not having the records, but instead, may be due to corrections made at NCHS. Because CPSC receives the death certificates directly from the states, CPSC records do not contain information from NCHS when an ICD-10 code changed for a specific death certificate; so CPSC staff has no way of correcting CPSC records to come into accord with NCHS records. For this report, CPSC staff have made the assumption that, over time, the number of death certificates with ICD-10 codes changed by NCHS staff to the codes of interest (X47 and Y17) would approximately equal those changed from the code of interest.

Table A.3 shows the weighting factors used to calculate the estimates for the years 1999–2009, based on the information available to CPSC staff.

Table A.3: CO Fatality Cases and Weighting Factors Used to Calculate the Estimates for the Years 1999–2009

Year	NCHS Total	Total in CPSC Databases*	In-Scope Cases[+]	Weighting Factor
1999				
X47	542	469	92	1.1557
Y17	80	66	1	1.2121
2000				
X47	600	551	126	1.0889
Y17	76	70	1	1.0857
2001				
X47	596	520	102	1.1462
Y17	79	62	3	1.2742
2002				
X47	642	599	168	1.0718
Y17	71	61	1	1.1639
2003				
X47	633	625	149	1.0128
Y17	89	75	2	1.1867
2004				
X47	566	527	154	1.0740
Y17	86	72	2	1.1944
2005				
X47	650	590	171	1.1017
Y17	92	70	1	1.3143
2006				
X47	585	527	161	1.1101
Y17	74	53	1	1.3962
2007				
X47	605	580	173	1.0431
Y17	89	68	4	1.3088
2008				
X47	677	649	161	1.0431
Y17	68	53	6	1.2830
2009				
X47	734	734	143	1.0000
Y17	72	47	2	1.5319

+   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/EPHA.
    CPSC Death Certificate File, CPSC In-Depth Investigation File, Abbreviated Death Certificate File,
    National Center for Health Statistics Mortality File, 1999–2009.

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 cases, 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 were treated.

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

Reports of non-fire CO poisoning deaths were retrieved from the DTHS and ABDT files based on the following criteria: date of death between 1/1/1999 and 12/31/2009, and ICD-10 code of X47 or Y17. Death certificates entered into the CPSC's database prior to July 23, 2012, were included in this analysis. Whenever possible, each CO death was reviewed and coded by the author, 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 IDI report, then 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 being burned alone and in the absence of 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 grill, LP fish cooker, 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 were original equipment installed on a recreational vehicle (RV), trailer, camper, or boat were considered out of scope, as they are outside the jurisdiction of the CPSC.

Appendix B: National Estimates of Consumer Product-Related CO Poisoning Deaths, 1980 to 2009

Figure B.1 below graphically suggests a trend of the estimated CO fatalities from 1980 to 2009. 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.
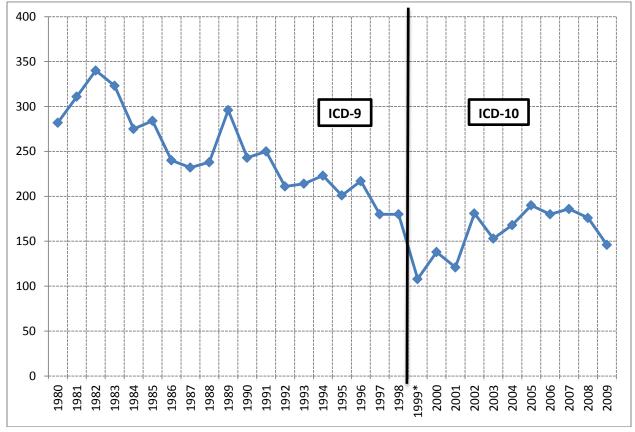
Figure B.1: Estimated Non-Fire CO Poisoning Deaths Associated with Consumer Products: 1980–2009

* Implementation of ICD-10.

Table B.1 presents the annual estimates from 1980 to 2009, and the 3-year average mortality rates associated with each year, where 3 years of data were available. The 3-year average mortality rate is presented in the table for the mid-point year. The estimated 3-year average mortality rate decreased from the 1982 high of 14.02 per 10 million population, to a 3-year average rate of 4.34 per 10 million in 2000, a reduction of 69 percent. Subsequently, the 3-year average rate has been increasing annually through 2006, to a rate of 6.21. The current 2008 estimate of 5.56 is slightly less than the previous 2 years, but still 28 percent above the 2000 low average. The year 2008 is the last year for which data are available to calculate a 3-year average.

Table B.1: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1980−2009

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	5.09
2000	138	282,172	4.34
2001	121	285,082	5.15
2002	181	287,804	5.27
2003	153	290,326	5.76
2004	168	293,046	5.81
2005	190	295,753	6.06
2006	180	298,593	6.21
2007	186	301,580	5.99
2008	176	304,375	5.56
2009	146	307,007	

Note: The 3-year average mortality rate is reported at the mid-point 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/EPHA.
            U.S. Census Bureau, Statistical Abstract of the United States: 2012 (excluding Armed Forces overseas).

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.[11] 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

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[11] See Appendix B of Mah (2001) for details.

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 2008, 3-year average mortality rate (2.30) for generators alone was more than four times greater than for the 2000, 3-year average rate (0.54), and the estimated 3-year average rate has increased each year from 2000 through 2006, with a slight decrease in 2007 and 2008. In each of the last 5 years (2005 through 2009), 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 that there were more EDT-associated CO deaths than heating system-associated CO deaths.

Table B.2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators, 1999−2009

Year	Estimate[+]	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	7	279,040	
2000	19	282,172	0.54
2001	20	285,082	0.95
2002	42	287,804	1.29
2003	49	290,326	1.52
2004	41	293,046	2.02
2005	88	295,753	2.41
2006	85	298,593	2.69
2007	68	301,580	2.43
2008	77	304,375	2.30
2009	65	307,007	

+ 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 3-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 in U.S. Census population 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 2000, 3-year annual average mortality rate was 3.79. The 2008, 3-year average mortality rate was 3.26, a decrease of 14 percent. In fact, the 3-year averages have dropped slightly each year since the 2003 high point. With generators included, the mortality rate increased from 4.34 per 10 million to 5.56 in the same time span, an increase of 28 percent.

Table B.3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999–2009 (Excluding Generator-Related Deaths)

Year	Estimate	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	101	279,040	
2000	119	282,172	3.79
2001	101	285,082	4.20
2002	139	287,804	3.99
2003	104	290,326	4.25
2004	127	293,046	3.79
2005	102	295,753	3.65
2006	95	298,593	3.52
2007	118	301,580	3.45
2008	99	304,375	3.26
2009	81	307,007	

+ Excludes estimates of deaths associated with a generator only.

Note 1: The 3-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 in U.S. Census population estimates.

Table B.4 shows the mortality rates of all engine-driven tools, including generators through 2008. Even though the average mortality rate in 2007 and 2008 dropped slightly since the 2006 high (3.18), it can be seen in the table that the average mortality rate has more than tripled from the 2000, 3-year average rate (0.72), to the average rate for 2008 (2.65).

Table B.4: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators and Other Engine-Driven Tools, 1999–2009

Year	Estimate	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	13	279,040	
2000	26	282,172	0.72
2001	22	285,082	1.17
2002	52	287,804	1.51
2003	56	290,326	1.88
2004	56	293,046	2.43
2005	102	295,753	2.95
2006	104	298,593	3.18
2007	79	301,580	2.86
2008	85	304,375	2.65
2009	78	307,007	

+ 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 that includes one estimated death associated with a generator and another EDT.
Note 1: The 3-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 in U.S. Census population 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, 3-year mortality rate decreased by 20 percent of non-engine-driven tool consumer products, with the 2000 average mortality rate of 3.62 and 2.91 in 2008. When all products are included, there has been a 28 percent increase in the CO mortality rate from the 2000 average rate, increasing from 3-year average mortality rate of 4.34 in 2000, to 5.56 in 2008. 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, 1999−2009 (Excluding Generator- and Other Engine-Driven Tool-Related Deaths)

Year	Estimate	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	95	279,040	
2000	112	282,172	3.62
2001	99	285,082	3.98
2002	129	287,804	3.77
2003	97	290,326	3.88
2004	112	293,046	3.38
2005	88	295,753	3.11
2006	76	298,593	3.02
2007	107	301,580	3.03
2008	91	304,375	2.91
2009	68	307,007	

+ Excludes estimates of deaths associated with EDTs only. Multiproduct-associated incidents are included here because an EDT could not be identified as the only product 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 3-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.

Appendix C: Regional Definitions

1) Northeast comprises New England and Middle Atlantic states.
   a) New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.
   b) Middle Atlantic: New York, New Jersey, and Pennsylvania.
2) Midwest comprise East North Central and West North Central states.
   a) East North Central: Ohio, Indiana, Illinois, Michigan, and Wisconsin.
   b) West North Central: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas.
3) South comprises South Atlantic, East South Central and West South Central states.
   a) South Atlantic: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida.
   b) East South Central: Kentucky, Tennessee, Alabama, and Mississippi.
   c) West South Central: Arkansas, Louisiana, Oklahoma, and Texas.
4) West comprises Mountain and Pacific states.
   a) Mountain: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada.
   b) Pacific: Washington, Oregon, California, Alaska, and Hawaii

Source: U.S. Census Bureau 2012 Statistical Abstract
http://www.census.gov/compendia/statab/cats/population.html

References

Hnatov, Matthew V., Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 2008 Annual Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission. 2011. <http://www.cpsc.gov/library/foia/foia11/os/co10.pdf >

Hnatov, Matthew V., *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999–2011*. Washington, D.C.: U.S. Consumer Product Safety Commission. 2012. http://www.cpsc.gov/library/foia/foia12/os/cogenerators.pdf.

Long, K., Saltzman, L. (1995). Non-fire Carbon Monoxide Incidents: Morbidity and Mortality Related to the Use of Household Appliances. Washington, D.C.: U.S. Consumer Product Safety Commission.

Mah, J., Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 1998 Annual Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission. 2001. <https://www.cpsc.gov/library/co98.pdf>

Vagts, S., Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 1999 and 2000 Annual Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission. 2003. <https://www.cpsc.gov/library/co03.pdf>

Vagts, S., Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 2001 Annual Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission. 2004. <https://www.cpsc.gov/library/co04.pdf>

U.S. Census Bureau. Statistical Abstract of the United States: 2012.

U.S. Census Bureau. American Factfinder. <http://factfinder.census.gov>

U.S. Department of Agriculture. Briefing Rooms: Measuring Rurality. 7 Nov. 2008 <http://www.ers.usda.gov/briefing/Rurality/>

University of Washington, WWAMI Rural Health Research Center. Rural-Urban Commuting Area Codes (version 2.0). 5 Jan. 2009 <http://depts.washington.edu/uwruca/>