Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products
2012 Annual Estimates

Matthew V. Hnatov
U.S. Consumer Product Safety Commission
Directorate for Epidemiology
Division of Hazard Analysis
4330 East West Highway
Bethesda, MD 20814
October 2015

CPSA 6(b)(1) CLEARANCE OF PUBLIC
NO MFRS PRVTLBLRS OR PRODUCTS IDENTIFIED 11/6/15
EXCERPTED BY: PETITIONS RULEMAKING ADMIN. PRCDG
WITH PORTIONS REMOVED:

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

Table of Contents

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 2012, and companion statistics since 2002. Because U.S. Consumer Product Safety Commission ("CPSC") staff continues to receive reports of CO poisoning fatalities for 2012, the 2012 estimates may change in subsequent reports.[1]

Some of the key findings in this report are:

For 2012:

- There were an estimated 138 unintentional non-fire CO poisoning deaths associated with consumer products under the CPSC's jurisdiction. The estimated annual average from 2010 to 2012 was 153 deaths.[2]

- *Engine-Driven Tools ("EDTs")* were associated with the largest percentage of non-fire CO poisoning fatalities at 46 percent (estimated 63 deaths). *Heating Systems*-related CO fatalities were associated with the second highest percentage, 35 percent, of non-fire CO poisoning fatalities (48 deaths). All other product categories comprised less than 5 percent of the total CO poisoning deaths in 2012. The *Multiple Products* category comprised 4 percent of the total (an estimated 5 deaths); however, all deaths were associated with EDTs and/or heating systems.

Generators and Other EDTs[3]:

- There were an estimated 65 CO fatalities in 2012 associated with *EDTs*, including all three of the *Multiple Products* deaths in which an EDT and another potential CO-producing product were also in use. Fifty-nine of the 65 EDT-related deaths, including the three multiple product deaths that involved an EDT, involved generators. Since 2002, portable generators have been associated with more non-fire CO fatalities than any other consumer product under CPSC jurisdiction.

[1] Note that the estimates for individual categories may not sum to that of the broader category due to rounding effects.

[2] Not all of these fatalities are addressable by an action the CPSC could take; however, the purpose of this report was not to evaluate the addressability of the incidents but rather to update the estimates of the number of consumer products associated with CO poisoning deaths.

[3] 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, 2004–2014*. http://www.cpsc.gov/library/foia/foia12/os/cogenerators.pdf.

Heating Systems:

- Of the estimated 48 *heating systems*-related fatalities in 2012, 83 percent (40 deaths) involved gas heating equipment. Natural gas heating equipment accounted for 33 percent (16 deaths) of all fuel types of gas heating system-related fatalities; liquefied petroleum (LP or propane) gas heating accounted for 40 percent (19 deaths); and an additional 10 percent (5 deaths) were identified as unspecified gas heating. Kerosene-fueled (1 deaths) heating systems accounted for 2 percent of heating system fatalities. Six additional fatalities (13 percent) were associated with heating systems, where the fuel type could not be ascertained from CPSC records.

Location/Demographics:

- CPSC staff is aware of 86 fatal non-fire CO incidents involving consumer products in 2012. Eighty-one percent of these incidents involved a single fatality.

- Eighty-two percent (estimated 113 deaths) of the estimated 138 CO deaths in 2012 occurred in a home location. Of these 113 estimated fatalities, 5 occurred in an external structure at a residence, such as a shed or detached garage, and 1 occurred in a non-fixed location domicile (*e.g.*, camper trailers or boats used as homes) used as a permanent home, or a structure not designed for habitation used as a home (*e.g.*, sea-land shipping container, metal shed). Additionally, an estimated 16 percent (22 deaths) occurred in tents, camper trailers, and other temporary shelters.

- More CO fatalities occurred in the cold months of the year. In 2012, 53 percent (73 of 138 estimated deaths) occurred during the four cold months of November, December, January, and February.

- In the three most recent years of this report (2010–2012), adults 45 years and older comprised more than two-thirds (an annual average of 68 percent) of all non-fire, consumer product-related CO deaths, while this age group makes up only about 39 percent of the U.S. population. Conversely, children younger than 15 years of age accounted for an annual average of only 3 percent of the yearly CO poisoning deaths, while this age group makes up about 20 percent of the U.S. population.

- In 2012, 68 percent (an estimated 94 deaths) of CO poisoning victims were males. This percentage is slightly lower than what has been observed over the previous 10 years of the report where an average of 74 percent of the fatalities were males.

- 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 2010 through 2012 time frame. The proportion of Hispanic victims (irrespective of race) is significantly lower than the proportion of Hispanic Americans in the U.S. population (8% versus 17%), while the proportion of Black or African American victims was significantly greater than the percentage of Black or African Americans in the U.S. population (25% versus 12%) during this time period.

- The estimated proportion of all CO poisoning fatalities that occurred in non-urban locations (42% in 2010 through 2012) is larger than the proportion of the U.S. population living in these areas (26%). The disparity is even higher in non-home locations where deaths at non-urban locations accounted for 56 percent of all CO fatalities occurring at non-home locations.

Historical Data:

- Regression models indicate that there is insufficient statistical evidence to support a conclusion that there is a trend in non-fire CO fatalities from 2002 to 2012; although the most recent years' estimates are below the peak years of this report (2005 through 2007).

- The CO poisoning 3-year average mortality rate for 2010 through 2012 associated with consumer products (4.92 per 10 million population) is approximately 13 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 all consumer products, excluding generators and other EDT products, the 3-year average mortality rate has decreased by 25 percent from 3.44 (the 2000 3-year average) down to a 2.57 3-year average mortality rate in 2011 (the average rate for 2010 through 2012). Conversely, the 3-year average mortality rate of CO poisoning from engine-driven tools during the same time period nearly tripled, increasing from 0.72 for 2000, up to 2.05 for 2011. Details are given in Appendix B of this report.

- The data indicate that EDTs and generators, in particular, have had a substantial impact on the CO poisoning mortality rate involving consumer products.

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, an individual's 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 use. 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, but for healthy adults, CO fatalities typically require levels above 50 percent COHb.[4]

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) often produce an irritating smoke that can alert the victim to a potentially hazardous situation. EDTs powered by gasoline engines produce large amounts of CO, even when they are run where there is sufficient oxygen available for combustion; yet EDTs 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. However, 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.

[4] 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

The national estimates presented in this report are based on death certificate records obtained from 50 states and the District of Columbia directly, augmented by information collected in CPSC's In-Depth Investigations ("IDIs"), and to a lesser extent, news articles and medical examiners' reports contained in the CPSC Injury or Potential Injury Incident ("IPII") database. Death certificate data from some states, for a partial year or even an entire year, can lag for months or even years and may not be available in time for use in this report.

The estimates presented in this report are based on reporting as of July 14, 2015, of consumer product-related CO poisoning fatalities that occurred through 2012. 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 only about 80 percent of all the fatal CO poisoning deaths that occurred in 2012, in the United States. By comparison, for the 10 years covered in this report before 2012, CPSC records contain approximately 95 percent of all the fatal CO poisoning deaths that occurred in the United States reported to NCHS. From this comparison, CPSC anticipates that lagged reporting for incidents that occurred in 2012 will continue. Appendix A of this report describes the process used to generate the national estimates presented in this report.

During 2012, an estimated 138 CO poisoning deaths were associated with the use of a consumer product under the jurisdiction of the CPSC. CO 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. The estimated 138 consumer product-related CO fatalities in 2012 are lower than any of the previous 10 years, though heating systems and generator deaths, the two largest categories, are on par with previous years. It should be noted that as of the data pull date of July 14, 2015, CPSC data records only contained approximated 80 percent of the CO-related death certificates present in the NCHS database. It is anticipated that when the records become available, the estimates for 2012 may change appreciably.

Although multiple factors may contribute 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. CPSC staff produces the CO estimates by associated consumer products to identify product groups involved in fatal CO scenarios and to monitor this distribution over time. Within the individual, product-specific CPSC projects, additional 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 2002 through 2012 are presented in two formats: by product category (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 (2010 through 2012). Data collection was only partially complete for 2012, and estimates for this year may change in the future when additional data become available. Therefore, data for 2012 are reported using italic font in the tables.

Estimated numbers presented in this document represent national estimates of unintentional non-fire deaths attributed to CO poisoning associated with the use of consumer

products. Generator and other EDT death estimates would not be expected to match *observed* fatality counts presented in this report or 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, 2004–2014."

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 138 CO poisoning deaths associated with a consumer product that occurred between January 2012 and December 2012, *Heating Systems* were associated with 48 deaths (35% of the total consumer product estimate). Of the 48 estimated deaths associated with heating systems, the majority (83% or 40 fatalities) involved gas heating systems. Natural gas heating systems were associated with an estimated 16 deaths (33% of all heating system-related deaths). LP gas[5] heating was associated with an estimated 19 deaths (40% of heating system-related deaths); and unspecified gas heating was associated with an estimated 5 deaths (10% of heating system-related deaths). There was also an estimated one death (2% of heating system-related deaths) associated with a kerosene-burning heater. In 2012, there were no reported coal-, oil-, wood-, or diesel-fueled heating system fatalities. Additionally, in 2012, there were an estimated six CO deaths (13% of heating system-related deaths) associated with heating systems with unspecified 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 16 deaths in 2012 that were associated with natural gas heating systems, all involved installed furnaces. Of the estimated 19 deaths in 2012 that were associated with LP gas heating systems, 10 (53%) 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, 1-pound propane bottles, or tank top heaters that used bulk tanks larger than 1 pound.

Table 1 indicates that in 2012, an estimated five CO deaths (4% of the 138 total consumer product estimate) were associated with charcoal or charcoal grills. Additionally, in 2012, an estimated four deaths (3%) were associated with gas ranges or ovens; an estimated five deaths (4%) were associated with water heaters; an estimated three deaths (2%) were associated with a fuel-burning lantern; and an estimated one death each were associated with an unspecified-fueled chimney and an unidentified consumer product. Additionally, in 2012, an estimated five deaths were associated with multiple appliances (4% 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 63 CO poisoning deaths (46% of the estimated total for 2012) 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, an

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

estimated three of the five *Multiple Product* fatalities were associated with a generator being used in conjunction with another fuel-burning product for an estimated total of 65 CO fatalities associated with the use of an engine-driven tool (47% of the estimated total for 2012). Generator-associated deaths comprised the majority of this category. An estimated 59 CO poisoning deaths were associated with a generator, including the three *Multiple Product* fatalities involving an engine-driven tool in 2012 (91% of all engine-driven tool fatalities and 43% of the total consumer product estimate).

In recent years, the *Engine-Driven Tools* category has been associated with more CO fatalities than any other category. The estimated average number of CO fatalities associated with engine-driven tools (63, not including multiple product incidents) for 2010 through 2012, is greater than the average number associated with heating systems (52 deaths). Over the 11 years covered in this report, the total number of estimated CO fatalities associated with engine-driven tools (799) exceeds the estimates for heating systems (665). Estimated generator-related CO fatalities alone exceed those for heating systems over these 11 years (675 generator-related deaths versus 665 heating system-related deaths). Since 2005, each year a greater number of CO fatalities has been associated with engine-driven tools than with heating systems, with the exception of 2010 where there were an estimated 58 heating system-related deaths and 56 engine-driven tool-related deaths. Generator-related deaths comprise the majority engine-driven too-related CO fatalities accounting for 84% of all engine-drive tool-related fatalities.

Table 1 shows the estimated average annual number of CO poisoning deaths associated with various consumer products for 2010 to 2012. The average yearly total number of CO deaths for this 3-year period is estimated to be 153 (with a standard error of approximately 7.8). The 95 percent confidence interval[6] for this estimated average ranged from 120 to 187 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 2012.

The availability of detailed information regarding the condition of products associated with CO fatalities varies 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 either connects the flue outlet of the appliance and exhausts air to the outside through a ceiling or sidewall, or connects to a chimney. Some 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).

[6] 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, 2002–2012

	2010–*2012*+		Annual Estimates										
Consumer Product	**Average Estimate**	**Average Percent**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	***2012***+
Total	**153**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Heating Systems	**52**	**34%**	**93**	**67**	**85**	**51**	**49**	**66**	**58**	**41**	**58**	**49**	***48***
Furnaces (incl. Boilers)	**27**	**18%**	**47**	**29**	**43**	**14**	**30**	**29**	**29**	**16**	**30**	**22**	***29***
Coal	< 1	< 1%	1	*	1	*	*	*	*	*	*	1	*
Liquid Petroleum (LP) Gas	4	3%	16	3	8	1	9	*	3	1	7	*	*4*
Natural Gas	12	8%	21	19	23	6	19	20	18	10	15	6	*16*
Oil	1	1%	3	1	*	2	*	5	1	3	1	2	*
Unspecified Gas	6	4%	1	2	4	2	*	4	2	1	4	10	*4*
Unspecified Fuel	3	2%	4	4	8	3	2	*	5	1	2	2	*5*
Portable Heaters	**15**	**10%**	**26**	**25**	**20**	**23**	**14**	**17**	**13**	**8**	**19**	**13**	***12***
Diesel	*	*	1	*	*	*	*	*	*	*	*	*	*
Kerosene	1	1%	4	5	4	2	3	3	4	*	1	2	*1*
Liquid Petroleum (LP) Gas	13	8%	20	18	15	19	10	14	9	8	18	11	*10*
Natural Gas	*	*	*	2	*	*	*	*	*	*	*	*	*
Unspecified Gas	*	*	*	*	1	1	*	*	*	*	*	*	*
Unspecified Fuel	*	*	*	*	*	1	1	*	*	*	*	*	*
Wall/Floor Furnaces	**2**	**1%**	**9**	**4**	**6**	**2**	**2**	**9**	**3**	**6**	**5**	**1**	*****
Liquid Petroleum (LP) Gas	< 1	< 1%	4	1	5	*	*	4	1	5	1	*	*
Natural Gas	1	1%	4	3	1	2	2	5	2	1	2	*	*
Unspecified Fuel	1	1%	*	*	*	*	*	*	*	*	1	1	*
Room/Space Heaters	**4**	**3%**	**10**	**8**	**12**	**8**	**1**	**6**	**5**	**9**	**1**	**5**	***5***
Coal	1	1%	*	*	1	1	*	*	*	*	*	2	*
Liquid Petroleum (LP) Gas	2	1%	*	1	*	*	*	4	2	5	1	1	*4*
Natural Gas	*	*	5	3	6	*	1	*	2	2	*	*	*
Wood	< 1	< 1%	1	2	*	2	*	*	1	2	*	1	*
Unspecified Gas	< 1	< 1%	3	2	4	1	*	2	*	*	*	1	*
Unspecified Fuel	< 1	<1 %	*	*	*	3	*	*	*	*	*	*	*1*
Unspecified Heater/System	**5**	**3%**	**2**	*****	**3**	**3**	**1**	**5**	**8**	**2**	**4**	**8**	***3***
Liquid Petroleum (LP) Gas	2	1%	*	*	*	*	*	1	2	*	1	3	*1*
Natural Gas	< 1	< 1%	*	*	*	*	*	3	*	*	*	1	*
Unspecified Gas	1	1%	1	*	2	*	*	*	2	1	1	1	*1*
Unspecified Fuel	1	1%	1	*	1	3	1	1	4	1	1	2	*
Charcoal Grills, Charcoal	**11**	**7%**	**11**	**8**	**3**	**6**	**10**	**8**	**7**	**7**	**17**	**10**	***5***

Table 1 (continued)

Consumer Product	2010–*2012*+		Annual Estimates										
	Average Estimate	Average Percent	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Engine-Driven Tools	**64**	**42%**	**52**	**56**	**56**	**102**	**104**	**79**	**82**	**76**	**56**	**73**	***63***
Generators	54	35%	42	49	41	88	85	68	76	64	42	64	*56*
Other Engine-Driven Tools	10	7%	10	7	15	13	18	11	6	12	14	10	*7*
Gas Ranges or Ovens	**6**	**4%**	**3**	**3**	**4**	**6**	*****	**6**	*****	**4**	**5**	**8**	***4***
Liquid Petroleum (LP) Gas	1	1%	*	*	1	1	*	1	*	*	1	1	*1*
Natural Gas	2	1%	3	*	2	1	*	2	*	2	2	3	*
Unspecified Gas	2	1%	*	3	1	3	*	3	*	2	1	3	*3*
Gas Water Heaters	**5**	**3%**	**1**	**7**	**2**	**6**	**4**	**2**	**6**	**5**	**2**	**8**	***5***
Liquid Petroleum (LP) Gas	< 1	< 1%	*	3	1	2	*	1	1	2	*	1	*
Natural Gas	2	1%	1	3	*	*	3	*	1	1	2	4	*
Oil	*	*	*	*	*	*	*	*	1	*	*	*	*
Unspecified Gas	1	1%	*	1	1	3	1	1	1	1	*	1	*3*
Unspecified Fuel	1	1%	*	*	*	*	*	*	2	1	*	1	*3*
Lanterns	**2**	**1%**	**2**	**1**	**4**	**6**	**3**	*****	**4**	**1**	*****	**2**	***3***
Liquid Petroleum (LP) Gas	1	1%	2	1	4	6	3	*	4	1	*	1	*3*
Unspecified Fuel	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Grills, Camp Stoves	**1**	**1%**	**4**	**1**	**3**	*****	**2**	**2**	*****	*****	*****	**2**	*****
Kerosene	*	*	*	*	1	*	*	*	*	*	*	*	*
Liquid Petroleum (LP) Gas	1	1%	4	1	2	*	1	1	*	*	*	2	*
Unspecified Fuel	*	*	*	*	*	*	1	1	*	*	*	*	*
Other Products	**4**	**3%**	**2**	**2**	**3**	**3**	*****	**2**	**5**	**2**	**6**	**4**	***3***
Chimney – Unspecified Fuel	< 1	< 1%	*	*	*	1	*	*	*	*	*	*	*1*
Fireplace – Unspecified Gas	*	*	*	*	*	*	*	1	*	*	*	*	*
Fireplace – Wood	*	*	2	*	2	*	*	1	*	*	*	*	*
Fireplace – Coal	< 1	< 1%	*	*	*	*	*	*	*	*	1	*	*
Other Products – LP Gas	1	1%	*	2	*	1	*	*	3	1	2	2	*
Other Products – Natural Gas	*	*	*	*	*	1	*	*	*	1	*	*	*
Other Products – Unspecified Gas	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Unidentified Product	1	1%	*	*	1	*	*	*	*	*	2	1	*1*
Unidentified Product – LP Gas	*	*	*	*	*	*	*	*	2	*	*	*	*
Multiple Products	**9**	**7%**	**13**	**8**	**7**	**12**	**8**	**20**	**12**	**11**	**15**	**8**	***5***

\+ Data collection for 2012 is only partially complete and data are shown in italics. 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, 2002–2012.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 2 (beginning on page 14) 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 64 of the 138 (46%) estimated CO fatalities in 2012. *Gas-Fueled Products* were associated with 53 (38%) estimated fatalities and *Solid-Fueled Products* were associated with five (4%) estimated fatalities in the same time period. An additional four (3%) fatalities were associated with multiple products, where there were two or more different categories of fuel used. Twelve (9%) fatalities in 2012 were associated with consumer products where the fuel type was unknown. It should be noted that in multiproduct cases where the fuel types were the same for all involved products the incident is counted in the respective category summary.

In the *Gas-Fueled Products* category, the majority of CO fatalities in 2012 were associated with heating-related products. Of the estimated 53 gas-fueled appliance fatalities in 2012, 40 (75%) were associated with heating systems or heaters, including furnaces, portable heaters, and room or space heaters. Additionally, all of the estimated four fatalities in the *Multiple Gas-Fueled Products* category involved some type of gas heater. All but one of the estimated 64 liquid-fueled appliance-related fatalities in 2012 were associated with engine-driven tools (*e.g.*, generators, lawn mowers/garden tractors). Generators accounted for 56 of the estimated 64 fatalities (88%) in the *Liquid- Fueled Products* category for 2012. Additionally, an estimated three of the four CO fatalities associated with multiple products of different fuel types involved portable generators.

In 2012, an estimated five fatalities occurred in the *Solid-Fueled Products* category. All five were associated with charcoal or charcoal grills.

Table 2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products Organized by Fuel Type, 2002–2012

	2010–*2012*+		Annual Estimates										
Consumer Product	**Average Estimate**	**Average Percent**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	***2012*+**
Total	**153**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Gas-Fueled Products	**60**	**39%**	**92**	**70**	**87**	**53**	**51**	**80**	**58**	**53**	**70**	**58**	***53***
Natural Gas	18	12%	**35**	**30**	**32**	**10**	**26**	**30**	**28**	**17**	**23**	**15**	***16***
Furnace (incl. Boilers)	12	8%	21	19	23	6	19	20	18	10	15	6	*16*
Pool Heater	*	*	*	*	*	1	*	*	*	*	*	*	*
Portable Heater	*	*	*	2	*	*	*	*	*	*	*	*	*
Range/Oven	2	1%	3	*	2	1	*	2	*	2	2	3	*
Room/Space Heater	*	*	5	3	6	*	1	*	3	2	*	*	*
Wall/Floor Furnace	1	1%	4	3	1	2	2	5	3	1	2	*	*
Water Heater	2	1%	1	3	*	*	3	*	1	1	2	4	*
Unspecified Heater	< 1	< 1%	*	*	*	*	*	3	*	*	*	1	*
Other Appliance	*	*	*	*	*	*	*	*	*	1	*	*	*
Liquid Petroleum (LP) Gas	**27**	**18%**	**47**	**31**	**37**	**30**	**23**	**26**	**31**	**23**	**35**	**23**	***23***
Furnace (incl. Boilers)	4	3%	16	3	8	1	9	*	3	1	7	*	*4*
Generator	1	1%	*	*	*	*	*	*	*	*	2	*	*
Grill/Camp Stove	1	1%	4	1	2	*	1	1	*	*	*	2	*
Lantern	1	1%	2	1	4	6	3	*	4	1	*	1	*3*
Other Products	*	*	*	1	*	*	*	*	3	1	*	*	*
Pool Heater	< 1	< 1%	*	*	*	*	*	*	*	*	1	*	*
Portable Heater	13	8%	20	18	15	19	10	14	9	8	18	11	*10*
Range/Oven	1	1%	*	*	1	1	*	1	*	*	1	1	*1*
Refrigerator	1	1%	*	1	*	1	*	*	*	*	1	2	*
Room/Space Heater	2	1%	*	1	*	*	*	4	3	5	1	1	*4*
Unspecified Heater/System	2	1%	*	*	*	*	*	1	3	*	1	3	*1*
Wall/Floor Furnace	< 1	< 1%	4	1	5	*	*	4	1	5	1	*	*
Water Heater	< 1	< 1%	*	3	1	2	*	1	1	2	*	1	*
Unspecified Gas	**11**	**7%**	**5**	**8**	**15**	**11**	**1**	**11**	**3**	**5**	**6**	**17**	***10***
Furnace (incl. Boilers)	6	4%	1	2	5	2	*	4	2	1	4	10	*4*
Pool Heater	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Portable Heater	*	*	*	*	1	1	*	*	*	*	*	*	*
Range/Oven	2	1%	*	3	1	3	*	3	*	2	1	3	*3*
Room/Space Heater	< 1	< 1%	3	2	4	1	*	2	*	*	*	1	*
Fireplace	*	*	*	*	*	*	*	1	*	*	*	*	*
Wall/Floor Furnace	1	1%	*	*	*	*	*	*	*	*	*	*	*
Water Heater	*	*	*	1	1	3	1	1	2	1	*	1	*3*
Unspecified Heater	1	1%	1	*	2	*	*	*	1	1	1	1	*1*

Table 2 (continued)

Consumer Product	2010–*2012*+ Average Estimate	2010–*2012*+ Average Percent	Annual Estimates 2002	2003	2004	2005	2006	2007	2008	2009	2010	2011+	*2012*+
Multiple Gas-Fueled Products	**4**	**3%**	**4**	**1**	**3**	**2**	**1**	**13**	**2**	**8**	**6**	**3**	***4***
Liquid-Fueled Products	**68**	**44%**	**64**	**66**	**61**	**108**	**108**	**89**	**95**	**81**	**60**	**79**	***64***
Gasoline-Fueled	**63**	**41%**	**52**	**56**	**56**	**102**	**104**	**78**	**82**	**77**	**53**	**73**	***63***
Generator	53	35%	42	49	41	88	85	68	76	64	40	64	*56*
Other Engine-Driven Tools	10	7%	10	7	15	13	18	11	6	12	14	10	*7*
Kerosene-Fueled	**1**	**1%**	**4**	**5**	**5**	**2**	**3**	**3**	**4**	*****	**1**	**2**	***1***
Grill/Camp Stove	*	*	*	*	1	*	*	*	*	*	*	*	*
Portable Heater	1	1%	4	5	4	2	3	3	4	*	1	2	*1*
Oil-Fueled	**1**	**1%**	**3**	**1**	*****	**2**	*****	**5**	**2**	**3**	**1**	**2**	*****
Furnace (incl. Boilers)	1	1%	3	1	*	2	*	5	1	3	1	2	*
Water Heater	*	*	*	*	*	*	*	*	1	*	*	*	*
Wall/Floor Furnace	*	*	*	*	*	*	*	*	*	*	*	*	*
Diesel-Fueled	*****	*****	**1**	*****	*****	*****	*****	*****	**1**	*****	*****	*****	*****
Portable Heater	*	*	1	*	*	*	*	*	*	*	*	*	*
Water Heater	*	*	*	*	*	*	*	*	1	*	*	*	*
Multiple Liquid-Fueled Products	**2**	**1%**	**4**	**4**	*****	**2**	**1**	**2**	**5**	**1**	**5**	**1**	*****
Solid-Fueled Products	**12**	**8%**	**15**	**10**	**8**	**9**	**10**	**9**	**8**	**9**	**18**	**14**	***5***
Charcoal-Fueled	**11**	**7%**	**11**	**8**	**3**	**6**	**10**	**8**	**7**	**7**	**17**	**10**	***5***
Charcoal / Charcoal Grills	11	7%	11	8	3	6	10	8	7	7	17	10	*5*
Coal-Fueled	**1**	**1%**	**1**	*****	**2**	**1**	*****	*****	*****	*****	**1**	**3**	*****
Furnace (incl. Boilers)	< 1	< 1%	1	*	1	*	*	*	*	*	*	1	*
Room/Space Heater	1	1%	*	*	1	1	*	*	*	*	*	2	*
Chimney / Fireplace	< 1	< 1%	*	*	*	*	*	*	*	*	1	*	*
Wood-Fueled	**< 1**	**< 1%**	**3**	**2**	**2**	**2**	*****	**1**	**1**	**2**	*****	**1**	*****
Chimney/Fireplace	*	*	2	*	2	*	*	1	*	*	*	*	*
Room/Space Heater	< 1	< 1%	1	2	*	2	*	*	1	2	*	1	*

Table 2 (continued)

	2010–*2012*+		Annual Estimates										
Consumer Product	**Average Estimate**	**Average Percent**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	***2011*+**	***2012*+**
Unspecified Fuel Products	**9**	**6%**	**5**	**4**	**9**	**12**	**6**	**2**	**11**	**3**	**7**	***9***	***12***
Chimney	< 1	< 1%	*	*	*	1	*	*	*	*	*	*	*1*
Furnace (incl. Boilers)	3	2%	4	4	6	3	2	*	5	1	2	*2*	*5*
Grill/Camp Stove	*	*	*	*	*	*	1	1	*	*	*	*	*
Lantern	< 1	< 1%	*	*	*	*	*	*	*	*	*	*1*	*
Portable Heater	*	*	*	*	*	1	1	*	*	*	*	*	*
Room/Space Heater	< 1	< 1%	*	*	*	3	*	*	*	*	*	*	*1*
Unspecified Heater	1	1%	1	*	1	3	1	1	4	1	1	*2*	*
Wall/Floor Furnace	1	1%	*	*	*	*	*	*	*	*	1	*1*	*
Unidentified Product	1	1%	*	*	1	*	*	*	*	*	2	*1*	*1*
Water Heater	1	1%	*	*	*	*	*	*	2	1	*	*1*	*3*
Multiple Product - Different Fuels	**4**	**3%**	**4**	**4**	**2**	**8**	**6**	**5**	**5**	**2**	**4**	***3***	***4***
Gas & Liquid	2	1%	4	3	2	7	6	5	3	1	1	*2*	*3*
Gas & Solid	< 1	< 1%	*	*	*	1	*	*	*	1	*	*	*1*
Liquid & Solid	1	1%	*	1	*	*	*	*	1	*	2	*1*	*
Gas & Liquid & Unspecified	*	*	*	*	*	*	*	*	2	*	*	*	*

\+ Data collection for 2012 is only partially complete. Italicized estimates may change in the future if more reports of fatalities are received.
* No reports received by CPSC staff.
\# In 2011, there were an estimated three CO fatalities associated with an LP-fueled welder/generator being used as a generator.
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, 2002–2012.
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 2002 through 2012 in the *Engine-Driven Tools* category. During 2012, engine-driven tools were associated with an estimated 65 carbon monoxide poisoning deaths (47% of the 138 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 2012, there were three such deaths—all of which were associated with a generator and some type of LP cooking device. An estimated 59 of the 65 engine-driven tool-related CO poisoning deaths (91%) were associated with generators, or generators in conjunction with another fuel-burning product.

Table 3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Engine-Driven Tools, 2002–2012

Engine-Driven Tools	2010-*2012*+ Average Estimate	Average Percentage	Annual Estimate										
			2002	2003	2004	2005	2006	2007	2008+	2009	2010	2011	*2012*+
Total	**68**	**100%**	**58**	**63**	**59**	**110**	**106**	**85**	**93**	**78**	**61**	**78**	***65***
Generators	**54**	**79%**	**41**	**50**	**41**	**88**	**85**	**68**	**76**	**64**	**42**	**64**	***56***
Gasoline-fueled	**53**	**78%**	41	50	41	88	85	68	76	64	40	64	*54*
LP-fueled	**1**	**1%**	*	*	*	*	*	*	*	*	**2**	*	*
Other Engine-Driven Tools (OEDTs)	**10**	**15%**	**10**	**7**	**15**	**13**	**17**	**11**	**6**	**12**	**14**	**10**	***7***
Lawn Mowers	**5**	**7%**	**5**	**6**	**8**	**9**	**11**	**5**	**2**	**6**	**7**	**3**	***4***
Riding Mowers	4	6%	5	6	5	9	8	4	2	6	5	3	*3*
Walk Behind Mowers	*	*	*	*	1	*	*	*	*	*	*	*	*
Unspecified Mowers	1	1%	*	*	1	*	3	1	*	*	2	*	*1*
Paint Sprayer	< 1	< 1%	*	*	*	*	*	*	*	*	*	1	*
Power Washer	1	1%	*	*	2	3	1	1	*	1	*	2	*
Snow Blower/Thrower	1	1%	*	*	1	*	1	2	*	3	1	1	*
ATV	2	3%	1	*	1	1	*	*	2	*	4	2	*1*
Water Pump	< 1	< 1%	*	*	1	*	1	1	*	*	1	*	*
Welder	*	*	2	1	*	*	*	1	1	*	*	*	*
Air Compressor	*	*	*	*	1	*	1	*	*	*	*	*	*
Concrete Saw	*	*	1	*	1	*	*	*	1	*	*	*	*
Tiller	*	*	*	*	*	*	*	*	*	1	*	*	*
Go-Cart	*	*	*	*	*	*	*	*	*	1	*	*	*
Small Engine	*	*	*	*	*	*	1	*	*	*	*	*	*
Snowmobile	*	*	*	*	*	*	1	*	*	*	*	*	*
Wood Splitter	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Multiple Product: Engine-Driven Tools Involved	**4**	**6%**	**8**	**6**	**3**	**9**	**3**	**6**	**10**	**2**	**6**	**4**	***3***
Generator + OEDT	*	*	*	*	*	*	*	*	*	*	*	*	*
Generator + other Product	4	6%	6	5	2	9	3	6	8	2	6	3	*3*
Multiple OEDT	< 1	< 1%	*	*	*	*	*	*	2	*	*	1	*
OEDT + other product	*	*	1	1	1	*	*	*	*	*	*	*	*

\+ Data collection for 2012 is only partially complete, and data are shown in italics. Italicized estimates may change in the future if more reports of fatalities are received.

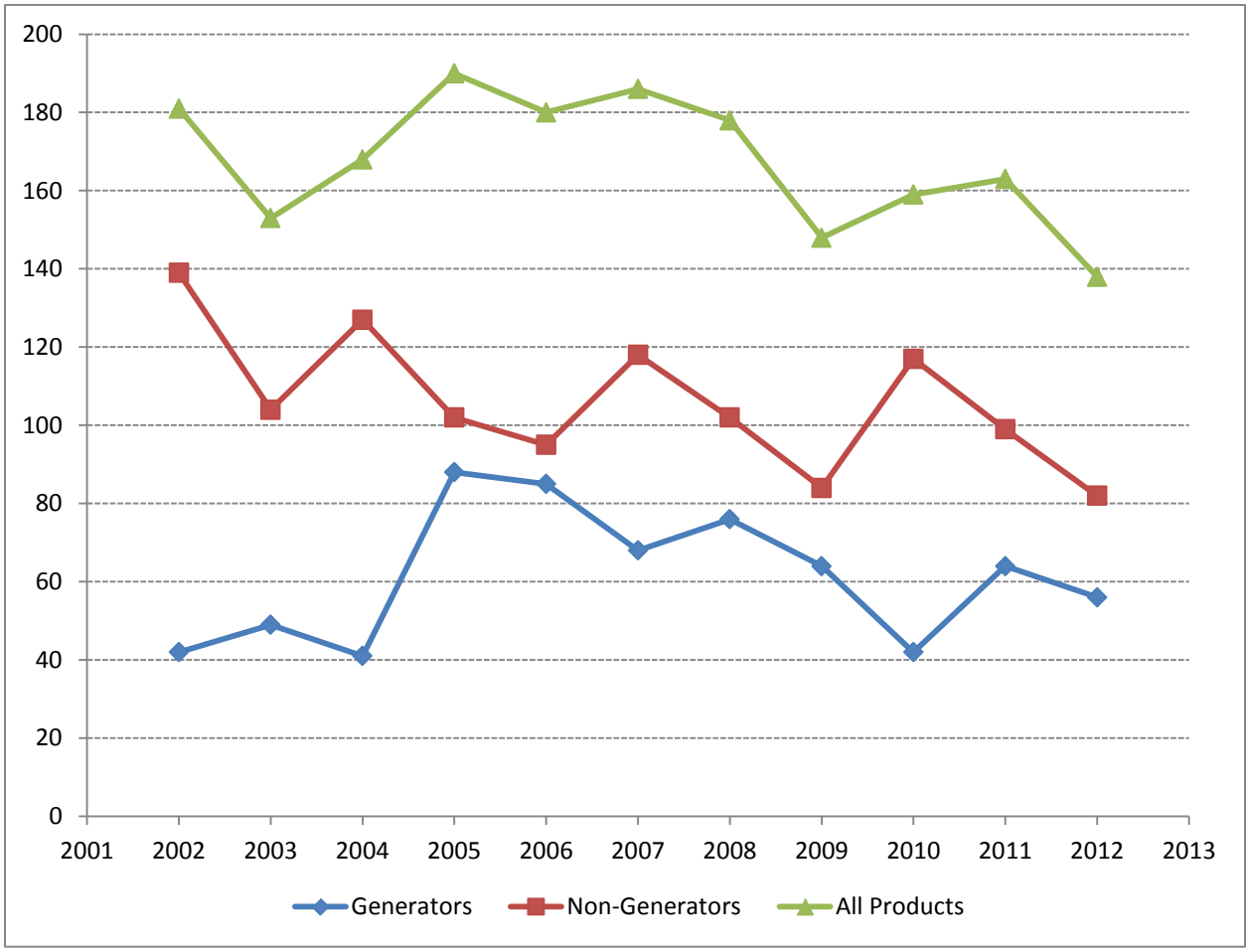
* No reports received by CPSC staff.

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, 2002–2012.

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

Figure 1 provides a graphic representation of the CO fatality trends related to: (1) all consumer products; (2) engine-driven tools, and (3) non-generator products. A regression analysis of the estimated number of all non-fire, consumer product-related CO poisoning fatalities from 2002 to 2012, indicates that there is insufficient evidence to conclude that there is a trend in the data (p-value = 0.1055). Due to reporting delays, national estimates for recent years, especially 2012, most likely will change in subsequent reports, though the estimates are not expected to change noticeably. As can be seen in Figure 1, the estimated number of non-generator CO fatalities fluctuates from year-to-year, but appears to be fairly steady across time. 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 2011 is below the peak 2005 and 2006 levels, but all years since have had a greater number of generator-related fatalities than the average number of fatalities (44) for the three years before 2005. Data from recent years, especially 2012, should be considered incomplete, and the numbers are expected to change.

Figure 1: Comparison of Trends in Consumer Product-Related Carbon Monoxide Deaths–2002 to 2012



Lawnmowers were associated with 54 percent (62 of 115) of the deaths in the *Other Engine-Driven Tools* category for the 11-year period. There were four other fatalities associated with a lawnmower and another product in this time period. There was an estimated average of five lawnmower-related CO fatalities per year in 2010 to 2012 (14 deaths). CO fatalities related to ATV exhaust were in the next largest subcategory with an estimated 11 deaths from 2002 to 2012, and nine occurring between 2008 through 2012. Additionally, power washers were associated with 10 deaths and snow blowers/throwers associated with nine CO fatalities over the 11-year period.

Table 4 shows that in 2012, 70 of the 86 fatal CO incidents (81% 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. 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 is based on CPSC IDI 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 18 percent (254 of 1,374 incidents) resulted in multiple fatalities, including 17 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, 2002–2012

Number of Deaths Reported in Incident	2010–*2012*+		Annual Incidents										
	Annual Average	Average Percent	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Total Incidents	107	100%	130	121	127	146	123	147	141	117	116	120	*86*
1	88	82%	101	96	105	123	93	125	119	93	100	95	*70*
2	17	16%	24	21	14	17	22	13	15	19	14	22	*14*
3	1	1%	1	3	7	5	6	8	5	4	1	1	*1*
4	1	1%	2	*	1	*	1	1	2	1	1	1	*
5	1	1%	2	1	*	*	1	*	*	*	*	1	*1*
6	*	*	*	*	*	1	*	*	*	*	*	*	*

+ Data collection for 2012 is only partially complete, and data are shown in italics. Italicized counts may change in the future if more reports of fatalities are received.

Note: Percentages do not add to 100% due to rounding.

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

Table 5 shows that, in 2012, an estimated 113 CO poisoning deaths occurred in home locations, including an estimated five deaths in detached structures at residential locations (*i.e.*, sheds, detached garages) and one in a structures not intended originally as a permanent residence (*i.e.*, camper trailers, sea-land shipping containers). From 2010 to 2012, an annual average of 129 CO poisoning deaths (84% of all CO fatalities) occurred at home locations. In 2012, an estimated 22 deaths took place in temporary shelters, such as campers, cabins, and trailers used for shelter. For 2010 to 2012, an annual average of 18 CO poisoning deaths (12%) took place in temporary

shelters. Carbon monoxide deaths in temporary shelters were most commonly associated with heating sources, generators, or lanterns. In 2012, more than half (an estimated 13 of 22; 59%) CO deaths in temporary shelters were associated with an LP heater or an LP heater and some other combustion product.

A small percentage of deaths due to CO poisoning involving a consumer product occurred in vehicles, such as passenger vans, trucks, automobiles, or boats. However, in 2012, there were no CO fatalities in this category. For the three year period 2010 to 2012, there was an annual average of five CO poisoning deaths (3%) took place in vehicles. All of the vehicle location incidents involved either a generator, LP heater, or involved the burning of charcoal inside the vehicle.

Table 5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Location of Death, 2002−2012

Location of Death	2010−*2012*+		Annual Estimate										
	Average Estimate	Average Percent	2002	2003	2004	2005	2006	2007	*2008*	2009	2010	2011	*2012*+
Total	153	100%	181	153	168	190	180	186	178	148	159	163	*138*
Home[1]	118	77%	121	109	121	120	119	138	124	109	125	122	*107*
Home – External Structure[2]	7	5%	15	11	10	16	14	11	13	7	5	10	*5*
Home – But Not House[3]	4	3%	8	2	*	6	4	4	6	1	5	5	*1*
Temporary Shelter	18	12%	32	22	22	32	36	22	20	18	17	15	*22*
Vehicles (including boats)	5	3%	4	9	8	14	6	8	9	12	6	9	*
Other	1	1%	*	*	8	2	1	2	3	*	1	1	*
Unknown	1	1%	*	2	*	*	*	*	2	*	*	1	*3*

\+ Data collection for 2012 is only partially complete, and data are shown in italics. Italicized estimates may change in the future if more reports of fatalities are received.

* No reports received by CPSC staff.

Note: Percentages do not add to 100% due to rounding.

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 container).

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, 2002–2012.

CPSC data indicate that there were more CO fatalities attributable to incidents that occurred in the cold months than in the warm months. This is most likely because of the use of furnaces and portable heaters in the cold months. Additionally, generators are often used in the cold months because of power outages due to snow and ice storms. Table 6 shows the annual estimated CO fatalities categorized by month of death for the 11 years covered by this report. In 2012, more than half of the 138 estimated CO fatalities (73) are attributable to incidents that occurred during the four cold months of November, December, January, and February. An estimated 48 fatalities (35%) are attributable to incidents that occurred during the transition months of March, April, September, and October; and an estimated 17 fatalities (12%) in the warm months of May, June, July, and August. Over the 10 years this report spans, an estimated 58 percent of CO fatalities are attributable to incidents that occurred during the cold months; an

estimated 28 percent are attributable to incidents that occurred during the transition months; and an estimated 14 percent of fatalities occurred in the warm months.

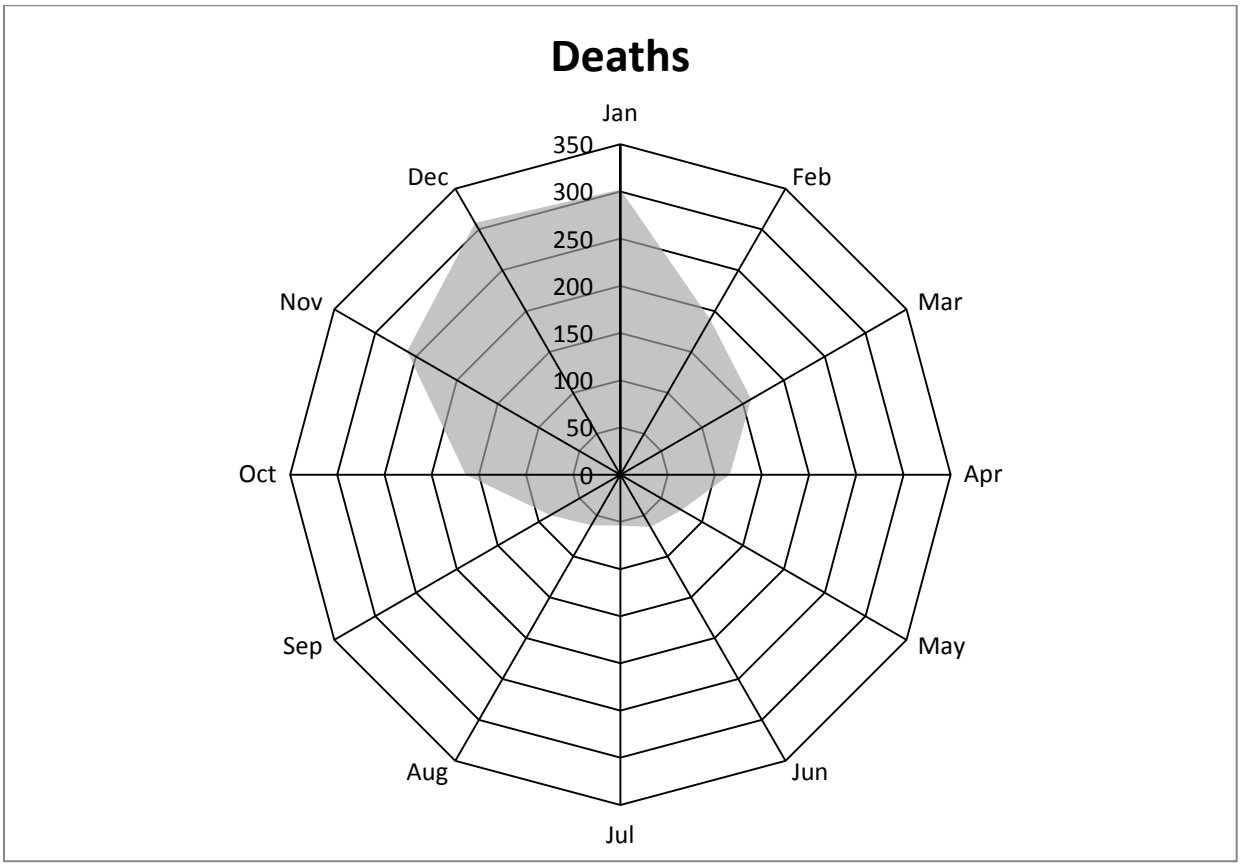
Table 6: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Month and Year of the Fatality, 2002–2012

Month of Death	2010–*2012*+		Annual Estimate										
	Average Estimate	Average Percent	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Total	**153**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Cold Months	**89**	**58%**	**94**	**96**	**107**	**98**	**95**	**109**	**110**	**85**	**109**	**85**	***73***
November	25	16%	27	32	26	18	23	21	28	12	18	34	*22*
December	28	18%	26	30	27	33	38	25	25	20	38	20	*26*
January	24	16%	20	22	34	37	14	43	31	29	38	24	*10*
February	12	8%	21	12	20	10	20	20	26	24	15	8	*14*
Transition Months	**45**	**29%**	**67**	**39**	**41**	**62**	**56**	**49**	**34**	**41**	**33**	**55**	***48***
March	13	8%	28	8	10	19	19	19	7	12	22	9	*7*
April	10	7%	9	13	8	9	16	15	7	8	6	11	*14*
September	7	5%	5	9	14	17	7	1	7	4	2	13	*7*
October	15	10%	25	9	9	17	14	14	13	17	2	23	*21*
Warm Months	**19**	**12%**	**19**	**19**	**19**	**31**	**29**	**29**	**32**	**21**	**17**	**23**	***17***
May	7	5%	4	3	5	4	9	9	16	5	8	8	*3*
June	4	3%	5	7	6	9	3	4	8	10	5	2	*5*
July	5	3%	2	6	4	12	4	5	3	4	2	4	*8*
August	3	2%	8	3	4	6	13	11	5	2	1	8	*1*

\+ Data collection for 2012 is only partially 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, 2002– 2012.
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 2002 through 2012, for each month. Notably, more CO deaths occur in the cold months, particularly, November, December, and January, than in warm months. Additionally, 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, 2002–2012



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 (2002–2012). From the data, it appears that consumer product-related CO fatalities are skewed toward older individuals. For the three most recent years (2010–2012), children younger than 15 years of age accounted for an annual average of 3 percent (an estimated 4 of 153) 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 68 percent (104 of 153) in 2010 to 2012, while only about 39 percent of the U.S. population is over 45 years old. In 2010 to 2012, adults age 65 years and older accounted for an annual average percentage of 26 percent of CO poisoning fatalities, double the age group's percentage of the U.S. population (13 percent).[7] 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. For the Chi-Square statistical analysis, the two younger groups ("Under 5" and "5−14") were combined due to their small estimated averages. Binomial tests indicate that all individual groups, with the exception of the "25−44" group, were found to be significantly different than what would be expected if there was no population group effect:

1. The "Under 15" group[8] was significantly lower (< 0.0001);
2. The "15–24" group was significantly lower (0.0038);
3. The "45–64" group was significantly higher (< 0.0001); and
4. The "65 and older" group was significantly higher (< 0.0001).

The disparity between the proportion of victims in a given age range can be seen in both of the two largest product categories – heating products and engine-driven tools products. However, the skew toward older victims appears to be even more pronounced in the heating products category. Only an estimated 1 percent of fatalities due to heating product were in the "Under 15" age range where there were an estimated 5 percent in the "Under 15" category associated with engine-driven tools. Conversely, an estimated 70 percent of heating product associated fatalities involved victims aged 45 or older compared to an estimated 62 percent of fatalities associated with engine-driven tools.

[7] U.S. Census Bureau, Population Division. Annual Estimates of the Resident Population for Selected Age Groups by Sex for the United States, States, Counties, and Puerto Rico Commonwealth and Municipios: April 1, 2010 to July 1, 2013.

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

Table 7: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Age of Victim, 2002–2012

Age	2010–*2012*+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Total	153	100%	**100%**	181	153	168	190	180	186	178	148	159	163	*138*
Under 5	1	1%	6%	2	6	3	*	2	8	2	3	1	*	*1*
5 - 14	3	2%	13%	9	9	11	7	4	6	8	2	1	4	*4*
15 - 24	9	6%	14%	11	17	4	17	21	18	15	14	12	9	*7*
25 - 44	37	24%	27%	56	46	43	46	59	34	54	43	39	36	*36*
45 - 64	64	42%	26%	51	55	68	86	58	70	68	59	69	63	*59*
65 and over	37	26%	13%	51	21	39	34	36	49	30	27	36	52	*31*

+ Data collection for 2012 is only partially complete. Italicized estimates may change in the future if more reports of fatalities are received.

* No reports received by CPSC staff.

Based on estimated U.S. population statistics for the five year average (2009-2013), centered on the mid-range year 2011.

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, 2002 - 2012.
U.S. Census Bureau, 2009-2013 5-Year American Community Survey.

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

Table 8 presents the distribution of estimated CO fatalities categorized by gender. In 2012, 68 percent of CO poisoning victims were males, and 32 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. Over the years, 2010 through 2012, the average percentage of male CO victims was 71 percent, and the average percentage of female victims was 29 percent. By contrast, about 49 percent of the U.S. population is male, and 51 percent are female.[9] 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, 2002-2012

Gender	2010–2012+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Total	**153**	**100%**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Male	**109**	**71%**	49%	126	118	123	140	145	132	140	109	121	111	*94*
Female	**45**	**29%**	51%	54	37	45	50	36	53	36	39	38	52	*44*

+ Data collection for 2012 is only partially complete. Italicized estimates may change in the future if more reports of fatalities are received.

Based on estimated U.S. population statistics for the five year average (2009-2013), centered on the mid-range year 2011.

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, 2002–2012.
U.S. Census Bureau, 2009-2013 5-Year American Community Survey.

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 2002 through 2012. Because of the growing proportion of the U.S. population of Hispanic descent, Hispanic victims were categorized separately, irrespective of their race. 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. Individuals reported as multi-race are included in the *Unknown/Other* category.

[9] Mid-range (2011) of 2014 U.S. Census estimates of the U.S. population.

The estimated percentage of the 2010–2012 annual average of non-Hispanic white CO fatalities closely mirrors the percentage of the U.S. population[10] at 59 percent and 63 percent, respectively. However, there appears to be a disproportionate number of Black or African American victims of CO poisoning, comprising 25 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 (8%) is below the percentage of Hispanics in the U.S. population (17%). Chi-square goodness-of-fit test results indicate that there is a significant statistical difference (p-value = 0.0001) 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 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. For the Chi-Square statistical analysis, the three smaller groups ("Asian/Pacific," "American Indian," and "Unknown/Other/Mixed") were combined due to their relative small proportion of the U. S. population. Binomial tests indicate that two race/ethnicity groups were 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 of 0.0059) than the proportion of Hispanics in the U.S. population. Additionally, the observed proportion of Black or African American CO fatalities was significantly higher (p-value < 0. 0001) 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, 2002−2012

Country of Origin	2010−2012+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2002	2003	2004	2005	2006	2007	2008	2009	2010	*2011*	*2012+*
Total	**153**	**100%**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	***163***	***138***
White (non-Hispanic)	**90**	**59%**	63%	138	102	116	134	107	122	122	93	82	*106*	*82*
Black or African American	**38**	**25%**	12%	20	26	27	36	36	35	30	20	43	*38*	*33*
Hispanic (All races)	**12**	**8%**	17%	14	14	20	15	19	23	14	11	18	*9*	*10*
Asian / Pacific[1]	**3**	**3%**	5%	4	10	2	2	13	3	1	3	4	*3*	*5*
American Indian[2]	**2**	**1%**	1%	2	2	*	*	6	1	5	1	5	*1*	*0*
Unknown / Other / Mixed[3]	**7**	**5%**	2%	1	*	2	2	*	2	4	19	8	*6*	*8*

\+ Data collection for 2012 is only partially complete. Italicized estimates may change in the future if more reports of fatalities are received.

* No reports received by CPSC staff.

\# Based on estimated U.S. population statistics for the five year average (2009-2013), centered on the mid-range year 2011.

1 Includes Asian, Pacific Islander, and Native Hawaiian

2 Includes American Indian, Native American, and Native Alaskan

3 Includes Unknown race, Other race, and Multiple races

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, 2002–2012.
U.S. Census Bureau, 2009-2013 5-Year American Community Survey.

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

[10] The "percentage of the U.S. population" is defined here as the mid-range of 2009 to 2011 (2010) of the 2013 U.S. Census estimates of the U.S. population.

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) in conjunction with the Center for Rural Health, School of Medicine and Health Sciences, University of North Dakota. 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.[11] This 21-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. ERS further delineated the characterization by cross-referencing each zip code in the United States to its RUCA code classification.[12] The development of the new update of the RUCAs to version 3.1 was developed by Center for Rural Health, School of Medicine and Health Sciences, University of North Dakota and ERS and is funded by the federal Office of Rural Health Policy (of HRSA, HHS) and the Economic Research Service (of Department of Agriculture). The zip code cross-reference was used to 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 2010 through 2012, in urban locations (58%), is smaller than the percentage of the U.S. population living in urban core locations (73%). The difference is offset by the larger percentages the other three categories: sub-urban locations (19% versus 15% of the U.S. population), large rural town locations (10% versus 6%), and small town/rural isolated locations (10% versus 5%). Additionally, due to lack of detail in some of the death certificates that CPSC receives, the exact location of a small number of incidents (2%) could not be ascertained. A look at the section, *Non-Home Locations*, helps to identify some of the disparity where each of the non-urban location categories. An average of 20 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 5 percent. In 2010 through 2012, an estimated average of five of 25 CO poisoning fatalities in non-home locations occurred in small town/rural isolated 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

[11] OMB BULLETIN NO. 13-01: Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Combined Statistical Areas, and Guidance on Uses of the Delineations of these Areas. February 28, 2013.

[12] Version 3.10 of the ZIP code Rural-Urban Commuting Areas ("RUCAs") geographic taxonomy, August 4, 2014. http://ruralhealth.und.edu/ruca/final310.csv.

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.

Table 10: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Population Density of Place of Death, 2002–2012

RUCA Population Density Designation	2010–*2012*+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
All Locations	**153**	**100%**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Urban Core	89	58%	73%	76	88	95	91	112	114	105	78	94	95	*80*
Sub-Urban	29	19%	15%	49	31	30	53	28	31	32	42	33	33	*25*
Large Rural Town	16	10%	6%	14	8	20	15	17	12	23	10	25	14	*8*
Small Town/ Rural Isolated	16	10%	5%	41	28	23	31	23	28	17	18	7	18	*20*
Unknown Location	3	2%	-	*	*	*	*	*	*	*	*	*	2	*7*
Home Locations	**128**	**100%**	**100%**	**144**	**121**	**131**	**141**	**138**	**153**	**143**	**117**	**135**	**137**	***113***
Urban Core	79	62%	73%	63	78	79	74	99	96	89	66	88	78	*72*
Sub-Urban	24	19%	15%	42	22	23	32	19	22	27	30	24	28	*20*
Large Rural Town	13	10%	6%	12	8	16	14	13	11	16	10	19	14	*5*
Small Town/ Rural Isolated	10	8%	5%	27	13	13	21	7	24	11	11	4	15	*12*
Unknown Location	2	2%	-	*	*	*	*	*	*	*	*	*	2	*5*
Non-Home Locations	**25**	**100%**	**100%**	**37**	**32**	**37**	**49**	**42**	**32**	**34**	**30**	**24**	**26**	***25***
Urban Core	11	44%	73%	13	10	15	17	13	18	16	11	6	18	*8*
Sub-Urban	6	24%	15%	8	8	8	21	9	9	5	12	8	5	*5*
Large Rural Town	3	12%	6%	2	*	4	1	3	1	7	*	6	*	*3*
Small Town/ Rural Isolated	5	20%	5%	14	14	10	10	17	4	6	7	4	3	*8*
Unknown Location	< 1	< 1%	-	*	*	*	*	*	*	*	*	*	*	*1*

\+ Data collection for 2012 is only partially 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 Rural Urban Commuting Area (RUCA 3.1) designation. U.S. population estimates by RUCA classification were determined by cross-referencing the Center for Rural Health, School of Medicine and Health Sciences, University of North Dakota/Economic Research Service, Department of Agriculture RUCA3.1 zip code table with the 2010 U.S. Census population estimates 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, 2002–2012.
Center for Rural Health, University of North Dakota School of Medicine and Health Sciences, ZIP code RUCA Version 3.10

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.

Table 11: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Geographical Region of Incident, 2002–2012

Region‡	2010–*2012*+		Estimated Percentage of US Population#	Annual Estimates										
	Average Estimate	Average Percent		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	*2012*+
Total	**153**	**100%**	**100%**	**181**	**153**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	***138***
Northeast	**29**	**19%**	**18%**	**18**	**24**	**16**	**33**	**24**	**44**	**28**	**14**	**23**	**43**	***21***
New England	7	5%	5%	6	3	7	7	8	10	12	5	5	16	*1*
Middle Atlantic	22	14%	13%	12	21	10	26	16	34	16	9	18	27	*20*
South	**56**	**37%**	**37%**	**69**	**53**	**58**	**74**	**57**	**61**	**51**	**55**	**55**	**55**	***59***
East South Central	11	7%	6%	12	15	16	9	10	9	10	19	12	13	*8*
South Atlantic	27	18%	19%	38	25	21	41	26	25	21	13	26	23	*33*
West South Central	18	12%	12%	19	12	21	24	21	27	21	23	17	19	*18*
Midwest	**38**	**25%**	**22%**	**58**	**41**	**49**	**46**	**54**	**47**	**58**	**48**	**49**	**33**	***32***
East North Central	31	20%	15%	38	34	30	31	40	25	39	28	40	27	*27*
West North Central	7	5%	7%	20	7	19	15	14	22	18	20	10	6	*5*
West	**30**	**20%**	**23%**	**33**	**33**	**37**	**33**	**46**	**33**	**40**	**31**	**31**	**32**	***26***
Mountain	11	7%	7%	21	12	20	18	21	17	25	16	11	9	*13*
Pacific	19	12%	16%	12	20	16	15	24	17	15	14	20	23	*13*

‡ 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 2011 is only partially complete. Italicized estimates may change in the future if more reports of fatalities are received.

Based on estimated U.S. population statistics for the three year average (2010-2012), centered on the mid-range year 2011.

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, 2002–2012.
U.S. Census Bureau, Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014.

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 and the District of Columbia. 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 (IDIs) 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 accidental 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 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. 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; thus, the incident 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. And for 2012, one case was reclassified. For 2008, 2009, 2010, and 2011 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 2010 through 2012 has been recalculated and is presented in Tables A.1.a through A.1.c.

Table A.1.a: Initial Categorization for 2010 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	675	125	19	206	350	236	586	108
Y17	98	7	2	27	36	34	70	30
Total	**773**	**132**	**21**	**233**	**386**	**270**	**656**	**138**

Table A.1.b: Initial Categorization for 2011 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	786	143	19	252	414	335	749	56
Y17	89	8	4	33	45	35	80	13
Total	**875**	**151**	**23**	**285**	**459**	**370**	**829**	**69**

Table A.1.c: Initial Categorization for 2012 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	736	105	13	208	326	252	578	171
Y17	114	1	0	25	26	56	82	32
Total	**850**	**106**	**13**	**233**	**352**	**308**	**660**	**203**

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, 2010–2012.

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 2010 through 2012 estimates of CO poisoning deaths.

Table A.2.a: Calculation Detail of the Final Computed 2010 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

	ICD-10 Code	
Variable	**X47**	**Y17**
n_1	125	7
n_2	586-19 = 567	70-2 = 68
n_3	675	98
Weighting Factor *(n_3 / n_2)*	1.1905	1.4412
N	148.8905	10.0882
Total Estimate	{148.8095 + 10.0882 = 158.8977 ~ 159}	

Table A.2.b: Calculation Detail of the Final Computed 2011 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
$\mathbf{n_1}$	143	8
$\mathbf{n_2}$	749-19 = 730	80-4 = 76
$\mathbf{n_3}$	786	89
Weighting Factor (n_3 / n_2)	1.0767	1.1711
N	153.9699	9.3684
Total Estimate	{153.9699 + 9.3684 = 163.3383 ~ 163}	

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, 2010-2011.

Table A.2.c: Calculation Detail of the Final Computed 2012 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
$\mathbf{n_1}$	105	1
$\mathbf{n_2}$	578-13 = 565	82-0 = 82
$\mathbf{n_3}$	736	114
Weighting Factor (n_3 / n_2)	1.3027	1.3902
N	136.7788	1.3902
Total Estimate	{136.7788 + 1.3902 = 138.1690 ~ 138}	

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, 2010-2011.

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 has 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 2002–2012, 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 2002–2012

Year	NCHS Total	Total in CPSC Databases*	In-Scope Cases+	Weighting Factor
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	660	166	1.0258
Y17	68	54	6	1.2593
2009				
X47	734	769	145	1.0000
Y17	72	52	2	1.3846
2010				
X47	675	567	125	1.1905
Y17	98	68	7	1.4412
2011				
X47	786	730	143	1.0767
Y17	89	76	8	1.1711
2012				
X47	736	565	105	1.3027
Y17	114	82	1	1.3902

\+ 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, 2002–2012.

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.

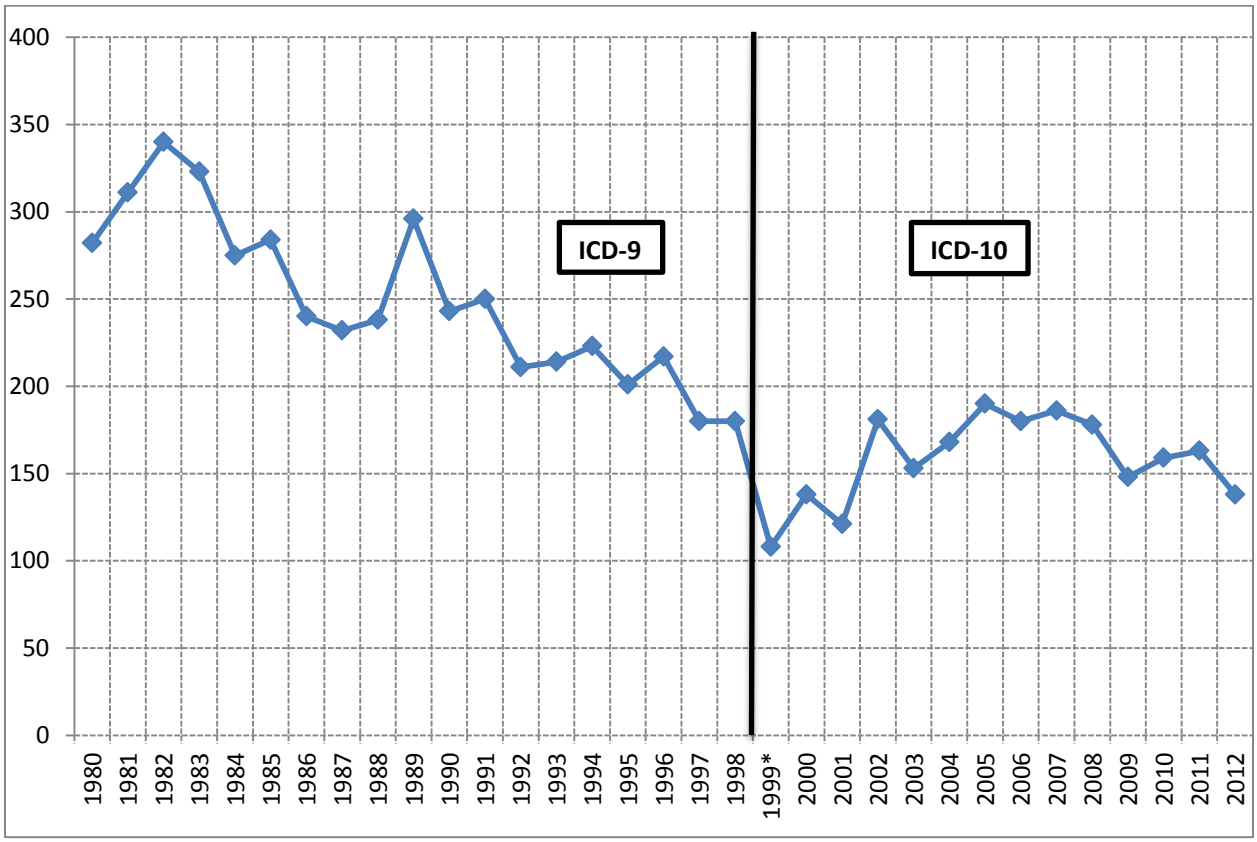
Reports of non-fire CO poisoning deaths were retrieved from the DTHS and ABDT files based on the following criteria: date of death between 1/1/2002 and 12/31/2012, and ICD-10 code of X47 or Y17. Death certificates entered into the CPSC's database prior to July 14, 2015, were included in this analysis. 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 2012

Figure B.1 below graphically suggests a trend of the estimated CO fatalities from 1980 to 2012. 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: 1980–2012



* Implementation of ICD-10.

Table B.1 presents the annual estimates from 1980 to 2012, 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. Since 2006, the rate has been slowly dropping with a slight uptick to the current 2011 estimate of 4.92. But the 2011 estimate is still 13 percent above the 2000 low average. The year 2011 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, 1980−2012

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	6.01
2008	178	304,375	5.49
2009	148	307,007	5.08
2010	159	309,347	4.89
2011	163	311,722	4.92
2012	138	314,112	

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, Population Division. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014

Before implementation of ICD-10 in 1999, generation of estimates for an important category of products: generators and other engine-driven tools was not possible.[13] With the advent of ICD-10 coding, generation of estimates of fatalities associated with generators and other engine-driven tools is now possible. Table B.2 presents a summary of the mortality rates associated with generators. This category rate steadily increased from 1999 through 2006, but has retracted somewhat from the 2006 high point. This increasing trend appears to be having an impact on the mortality rate of consumer product-related CO poisoning fatalities. However, the 2011, 3-year average mortality rate (1.73) for generators alone is still more than three times greater than for the 2000, 3-year average rate (0.54).

Table B.2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators*, 1999−2012

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	2.20
2008	76	304,375	2.00
2009	64	307,007	1.95
2010	42	309,347	1.82
2011	64	311,722	1.73
2012	56	314,112	

* Estimates are based on single source product incidents as multiple source incidents could be included in multiple categories.
+ 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.

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

Table B.3 shows the CO poisoning mortality rates associated with all consumer products, excluding generators. The data indicate that, when generators are excluded, there does not appear to be a trend in the mortality rate for consumer products. The 2000, 3-year annual average mortality rate was 3.60. The 2011, 3-year average mortality rate was 2.89, a decrease of 20 percent. In fact, the 3-year averages have dropped slightly each year from 2003 to 2010 with a slight uptick in 2011. However, the non-generator consumer product CO mortality rate has decreased by 26 percent from 3.93 per 10 million population in 2003 to the current (2012) estimate of 2.89 per 10 million.

Table B.3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999–2012 (Excluding Generator-Related Deaths)*

Year	Estimate	U.S. Population (thousands)	3-Year Average Mortality Rate per 10 Million Population
1999	95	279,040	
2000	117	282,172	3.60
2001	93	285,082	3.93
2002	126	287,804	3.65
2003	96	290,326	3.93
2004	120	293,046	3.48
2005	90	295,753	3.35
2006	87	298,593	3.07
2007	98	301,580	3.04
2008	90	304,375	2.97
2009	73	307,007	2.80
2010	102	309,347	2.76
2011	91	311,722	2.89
2012	77	314,112	

* Estimates are based on single source product incidents as multiple source incidents could be included in multiple categories.
+ 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 3-year average mortality rates of all engine-driven tools, including generators, through 2010. Even though the average mortality rates for 2007 through 2010 have dropped since the 2006 high (3.18), the table shows that the average mortality rate tripled from the 2000, 3-year average rate (0.72), to the average rate for 2012 (2.16).

Table B.4: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators and Other Engine-Driven Tools, 1999–2012*

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	2.61
2008	82	304,375	2.32
2009	76	307,007	2.26
2010	56	309,347	2.16
2011	73	311,722	2.05
2012	63	314,112	

* Estimates are based on single source product incidents as multiple source incidents could be included in multiple categories.
+ 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 25 percent of non-engine-driven tool consumer products (*i.e.*, excluding generator and other engine-driven tools), with the 2000 average mortality rate of 3.44 and 2.57 in 2011. When all consumer products are included, there has been a 13 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 4.92 in 2011, as shown in Table B.1. 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, 1999−2012* (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	89	279,040	
2000	110	282,172	3.44
2001	92	285,082	3.72
2002	116	287,804	3.44
2003	89	290,326	3.56
2004	105	293,046	3.07
2005	76	295,753	2.81
2006	68	298,593	2.58
2007	87	301,580	2.64
2008	84	304,375	2.62
2009	61	307,007	2.49
2010	88	309,347	2.42
2011	82	311,722	2.57
2012	70	314,112	

* Estimates are based on single source product incidents as multiple source incidents could be included in multiple categories.
\+ 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 comprises 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 2011 Annual Estimates. Washington, D.C.: U.S. Consumer Product Safety Commission. 2014. <http://www.cpsc.gov//PageFiles/136146/co12.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, 2004–2014*. Washington, D.C.: U.S. Consumer Product Safety Commission. 2015. <http://www.cpsc.gov/en/Research--Statistics/Carbon-Monoxide/Portable-Generator-Technical-Reports/>

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.

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.

U.S. Census Bureau, Population Division. Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014 (NST-EST2014-01). <http://www.census.gov/popest/data/state/totals/2014/>

U.S. Census Bureau, 2009-2013 5-Year American Community Survey: ACS Demographic and Housing Estimates. December 2014. <http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_DP05&src=pt>

U.S. Department of Agriculture, Economic Research Service. 2010 Rural-Urban Commuting Area Codes <http://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx>

Center for Rural Health, University of North Dakota School of Medicine and Health Sciences. Temporary Zip Ruca 3.10 File Access Page <https://ruralhealth.und.edu/ruca>

U.S. Office of Budget and Management. OMB BULLETIN NO. 13-01: Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Combined Statistical Areas, and Guidance on Uses of the Delineations of These Areas. February 28, 2013. <*http://www.whitehouse.gov/sites/default/files/omb/bulletins/2013/b-13-01.pdf*>