Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products
2014 Annual Estimates

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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 2014, and companion statistics since 2004. Because U.S. Consumer Product Safety Commission (CPSC) staff continues to receive reports of CO poisoning fatalities for 2014, the 2014 estimates may change in subsequent reports.[1]

Some of the key findings in this report are:

For 2014:

- There were an estimated 165 unintentional non-fire CO poisoning deaths associated with consumer products under the CPSC's jurisdiction. The estimated annual average from 2012 to 2014 was 149 deaths.[2]
- *Heating Systems*-related CO fatalities were associated with the largest percentage of non-fire CO poisoning fatalities at 39 percent of non-fire CO poisoning fatalities (an estimated 64 deaths). Additionally, in all seven Multiple Product CO fatalities, at least one of the products involved was some type of heating appliance, increasing the estimated total fatalities associated with a Heating System to 71 deaths (43 percent).
- *Engine-Driven Tools (EDTs)* were associated with the second highest percentage of non-fire CO poisoning fatalities at 38 percent (estimated 62 deaths) for EDTs alone, or 39 percent (64 deaths), including EDTs involved in incidents with Multiple Products).
- Thirty-one CO fatalities (19%) in 2014 were attributed to product categories other than Heating Systems or Engine-Driven Tools.

Generators and Other EDTs[3]:

- There were an estimated 64 CO fatalities in 2014 associated with *EDTs*, including two of the seven *Multiple Product* deaths in which an EDT and another potential CO-producing product were also in use. Fifty-seven of the 64 EDT-related deaths, including both of the multiple-product deaths that involved an EDT, involved generators. Since 2004, portable generators have been associated with an estimated 696 non-fire CO poisoning fatalities, more than any other consumer product under CPSC's 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, 2005–2016*.

Heating Systems:

- Of the estimated 64 *Heating System*-related fatalities in 2014, 88 percent (56 deaths) involved gas-heating equipment. Liquefied petroleum (LP or propane) gas heating equipment accounted for 70 percent of all fuel types of gas heating system-related fatalities (39 deaths); natural gas heating equipment accounted for 16 percent (9 deaths); and an additional 14 percent of the incidents (8 deaths) were identified as unspecified gas heating. Other heating system fuel sources associated with CO fatalities reported in 2014 included oil, coal, and kerosene. There was also a fatality reported associated with a heater where the fuel source was not reported.
- Additionally, a heating system was involved in all of the estimated seven Multiple Product-associated CO fatalities, primarily natural gas heating equipment.

Location/Demographics:

- CPSC staff is aware of 107 fatal non-fire CO incidents involving consumer products in 2014. Seventy-eight percent of these incidents involved a single fatality.
- Seventy-nine percent (estimated 130 deaths) of the estimated 165 CO deaths in 2014 occurred in a home location. Of these 130 estimated fatalities, 15 occurred in an external structure at a residence, such as a shed or detached garage; and 12 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 22 deaths occurred in tents, camper trailers, and other temporary shelters.
- A plurality of CO fatalities occurred in the cold months of the year. In 2014, almost half of the fatalities (82 of 165 estimated deaths) occurred during the 4 cold months of November, December, January, and February.
- In the 3 most recent years of this report (2012–2014), adults 45 years and older comprised about two-thirds (an annual average of 66 percent) of all non-fire, consumer product-related CO deaths, although 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 4 percent of the yearly CO poisoning deaths, although this age group makes up about 19 percent of the U.S. population.
- In 2014, 78 percent (an estimated 128 deaths) of CO poisoning victims were males. This percentage is slightly higher than any of the previous 10 years of the report, in which an average of 75 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 2012 through 2014 period. The proportion of Hispanic victims (irrespective of race) is significantly lower than the proportion of Hispanic Americans in the U.S. population (9% 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 (21% versus 12%) during this time period.

- An estimated 46 percent of all CO poisoning fatalities occurred in non-urban locations in 2012 through 2014, when the location was known. This is larger than the proportion of the U.S. population living in these areas (27%). The disparity is even greater in non-home locations, where deaths at non-urban locations accounted for 65 percent of all CO fatalities occurring at non-home locations, when the location was known.

Historical Data:

- Regression models, the statistical test of trend in non-fire CO fatalities from 2004 to 2014, indicate that there is significant evidence of a downward trend. However, it should be noted that the estimated number of consumer product-related CO fatalities in 2014 is greater than any of the previous 5 years. The CO poisoning 3-year average mortality rate for 2012 through 2014 associated with consumer products (4.72 per 10 million population) is approximately 9 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. The mortality rate has dropped from a post-2000 high of 6.21 per 10 million around 2006. However, for all consumer products, excluding generators and other EDT products, the 3-year average mortality rate has decreased by 27 percent from 3.44 (the 2000 3-year average) down to a 2.50 3-year average mortality rate in 2013 (the average rate for 2012 through 2014). Conversely, the 3-year average mortality rate of CO poisoning from generators and engine-driven tools during the same time period nearly tripled, increasing from 0.72 per 10 million population for 2000, up to 2.15 per 10 million population for 2013. 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. While non-EDT-related CO fatalities have dropped by 27 percent from 3.44 per 10 million in 2000 to 2.50 in 2013, EDT-related CO fatalities have increase by 299 percent per 10 million.

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 as 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 after 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 to 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 August 1, 2017, of consumer product-related CO poisoning fatalities that occurred through 2014. The National Center for Health Statistics (NCHS) has records of every death certificate filed in the United States and its territories. A comparison of CPSC records to NCHS records indicates that CPSC records have data on approximately only about 83 percent of all the fatal CO poisoning deaths that occurred in the United States in 2014. By comparison, for the 10 years covered in this report before 2014, CPSC records contain approximately 93 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 2014 will continue. Appendix A of this report describes the process used to generate the national estimates presented in this report.

During 2014, an estimated 165 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 incidents where the CO gas resulted from a fire or a motor vehicle, were intentional in nature, or were directly work related. Over the prior 10 years, the annual average was 166 estimated non-fire CO deaths from consumer products.

Although multiple factors may contribute to a CO poisoning fatality, the source of CO is virtually always a fuel-burning product. As mentioned, poor product maintenance by professionals or consumers, inadequate ventilation, faulty exhaust pathways, and poor user understanding of the hazard or 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 2004 through 2014 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 (2012 through 2014). As noted, data collection was only partially complete for 2014, and estimates for this year may change in the future when additional data become available. Therefore, data for 2014 are reported using italic font in the tables.

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, 2006–2016."

Table 1 (pages 11−12) 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 165 CO poisoning deaths associated with a consumer product that occurred between January 2014 and December 2014, *Heating Systems* were associated with an estimated 64 deaths (39% of the total consumer product estimate). Of the 64 estimated deaths associated with heating systems, the majority (88% or 56 fatalities) involved gas heating systems. Natural gas heating systems were associated with an estimated nine deaths (14% of all heating system-related deaths). LP gas[5] heating was associated with an estimated 39 deaths (61% of heating system-related deaths); and unspecified gas heating was associated with an estimated eight deaths (13% of heating system-related deaths). It should be noted that the proportion of heating system-related deaths associated with LP gas appliances in 2014 (61%) is significantly greater than 37 percent observed over the previous ten years covered in this report. The estimated LP Furnace-related CO fatalities in 2014 were higher than any of the previous 10 years (11 versus an average of 3.4), as were the estimates for Room/Space Heaters (7 versus 2.1) and Unspecified Heater/System (8 versus 0.9).

There was also an estimated one death (2% of heating system-related deaths) associated with oil-burning heaters; one death (2%) associated with coal-burning heaters and two from kerosene-burning heaters (3%). In 2014, there were no reported wood- or diesel-fueled heating system fatalities. Additionally, in 2014, there was an estimated one CO death (2% 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 nine deaths in 2014 that were associated with natural gas heating systems, six involved installed freestanding furnaces, and two involved wall- or floor-mounted furnaces and heaters. Of the estimated 39 deaths in 2014 that were associated with LP gas heating systems, 13 (33%) 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 camping heaters that used disposable propane tanks, 1-pound propane bottles, or tank top heaters that used bulk tanks larger than 1 pound.

In 2014, an estimated seven CO deaths (4% of the 165 total consumer product estimate) were associated with charcoal or charcoal grills. Additionally, in 2014, an estimated five deaths (3%) were associated with water heaters; an estimated five deaths (3%) were associated with

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

lanterns; and an estimated six death (4%) was associated with a grill or camp stove. In 2014, there were an estimated six fatalities associated with more uncommon appliances specified in Table 1 as *Other Products*. In 2014, these products included pool heaters, LP-fueled refrigerators and an outdoor fish cooker used indoors. In 2014, there were an estimated two deaths associated with an unidentified appliance – one was LP-fueled, while the fuel type of the other appliance was not reported. Additionally, in 2014, an estimated seven 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**.** In all seven deaths, one of the products involved was some type of heating system.

An estimated 62 CO poisoning deaths (38% of the estimated total for 2014) 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, two of the estimated seven *Multiple Product* fatalities were associated with an engine-driven tool being used in conjunction with another fuel-burning product for an estimated total of 64 CO fatalities (39% of the estimated total for 2014). Generator-associated deaths comprised the majority of deaths in this category. An estimated 57 CO poisoning deaths were associated with a generator, including two of the seven *Multiple Product* fatalities involving an engine-driven tool in 2014 (89% of all engine-driven tool fatalities and 35% 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 (65, not including multiple product incidents) for 2012 through 2014, is greater than the average number associated with heating systems (51 deaths). Over the 11 years covered in this report, the total number of estimated CO fatalities associated with engine-driven tools (822) exceeds the estimates for heating systems (610). Estimated generator-related CO fatalities alone exceed those for heating systems over these 11 years (696 generator-related deaths versus 610 heating system-related deaths). Generator-related deaths comprise the majority of engine-driven tool-related CO fatalities accounting for 85 percent 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 2012 to 2014. The average yearly total number of CO deaths for this 3-year period is estimated to be 149 (with a standard error of approximately 8.3). The 95 percent confidence interval[6] for this estimated average ranged from 114 to 185 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 2014.

The availability of detailed information regarding the condition of products associated with CO fatalities varies widely. However, information collected often describes conditions indicative of 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

[6] The confidence interval is based on a t-distribution with two degrees of freedom.

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 furnace-related conditions included compromised heat exchangers or filter doors or covers that were removed or not sealed. Some products were old and apparently not well 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).

Table 1: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Associated Fuel-Burning Consumer Product, 2004–2014

	2012–*2014*+		Annual Estimates										
Consumer Product	**Average Estimate**	**Average Percent**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	***2014*+**
Total	**149**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	***146***	***165***
Heating Systems	**51**	**34%**	**85**	**51**	**49**	**66**	**58**	**41**	**58**	**49**	**46**	***43***	***64***
Furnaces (incl. Boilers)	**24**	**16%**	**43**	**14**	**30**	**29**	**29**	**16**	**30**	**22**	**27**	***21***	***24***
Coal	*	*	1	*	*	*	*	*	*	1	*	*	*
Liquid Petroleum (LP) Gas	5	3%	8	1	9	*	3	1	7	*	4	*1*	*11*
Natural Gas	9	6%	23	6	19	20	18	10	15	6	15	*5*	*6*
Oil	2	1%	*	2	*	5	1	3	1	2	*	*5*	*1*
Unspecified Gas	7	5%	4	2	*	4	2	1	4	10	4	*10*	*6*
Unspecified Fuel	2	1%	8	3	2	*	5	1	2	2	5	*	*
Portable Heaters	**13**	**9%**	**20**	**23**	**14**	**17**	**13**	**8**	**19**	**13**	**11**	***12***	***17***
Diesel	*	*	*	*	*	*	*	*	*	*	*	*	*
Kerosene	1	1%	4	2	3	3	4	*	1	2	1	*	*2*
Liquid Petroleum (LP) Gas	12	8%	15	19	10	14	9	8	18	11	10	*12*	*13*
Natural Gas	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Unspecified Gas	*	*	1	1	*	*	*	*	*	*	*	*	*
Unspecified Fuel	*	*	*	1	1	*	*	*	*	*	*	*	*
Wall/Floor Furnaces	**2**	**1%**	**6**	**2**	**2**	**9**	**3**	**6**	**5**	**1**	*****	*****	***5***
Liquid Petroleum (LP) Gas	*	*	5	*	*	4	1	5	1	*	*	*	*
Natural Gas	1	1%	1	2	2	5	2	1	2	*	*	*	*2*
Unspecified Gas	1	1%	*	*	*	*	*	*	*	*	*	*	*2*
Unspecified Fuel	*	*	*	*	*	*	*	*	1	1	*	*	*
Room/Space Heaters	**7**	**5%**	**12**	**8**	**1**	**6**	**5**	**9**	**1**	**5**	**5**	***9***	***8***
Coal	1	1%	1	1	*	*	*	*	*	2	*	*1*	*1*
Liquid Petroleum (LP) Gas	5	3%	*	*	*	4	2	5	1	1	4	*3*	*7*
Natural Gas	1	1%	6	*	1	*	2	2	*	*	*	*2*	*
Wood	1	1%	*	2	*	*	1	2	*	1	*	*2*	*
Unspecified Gas	*	*	4	1	*	2	*	*	*	1	*	*	*
Unspecified Fuel	< 1	< 1%	*	3	*	*	*	*	*	*	1	*	*
Unspecified Heater/System	**4**	**3%**	**3**	**3**	**1**	**5**	**8**	**2**	**4**	**8**	**2**	***1***	***10***
Liquid Petroleum (LP) Gas	3	2%	*	*	*	1	2	*	1	3	1	*	*8*
Natural Gas	*	*	*	*	*	3	*	*	*	1	*	*	*
Unspecified Gas	< 1	< 1%	2	*	*	*	2	1	1	1	1	*	*
Unspecified Fuel	1	1%	1	3	1	1	4	1	1	2	*	*1*	*1*
Charcoal Grills, Charcoal	**8**	**5%**	**3**	**6**	**10**	**8**	**7**	**7**	**17**	**10**	**6**	***11***	***7***

Table 1 (continued)

Consumer Product	2012–*2014*+		Annual Estimates										
	Average Estimate	Average Percent	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Engine-Driven Tools	**65**	**44%**	**56**	**102**	**104**	**79**	**82**	**76**	**56**	**73**	**64**	***68***	***62***
Generators	56	38%	41	88	85	68	76	64	42	64	57	*56*	*55*
Other Engine-Driven Tools	9	6%	15	13	18	11	6	12	14	10	6	*13*	*7*
Gas Ranges or Ovens	**5**	**3%**	**4**	**6**	*****	**6**	*****	**4**	**5**	**8**	**4**	***10***	*****
Liquid Petroleum (LP) Gas	1	1%	1	1	*	1	*	*	1	1	1	*1*	*
Natural Gas	1	1%	2	1	*	2	*	2	2	3	*	*2*	*
Unspecified Gas	1	1%	1	3	*	3	*	2	1	3	2	*2*	*
Unspecified Fuel	2	1%	*	*	*	*	*	*	*	*	*	*5*	*
Gas Water Heaters	**4**	**3%**	**2**	**6**	**4**	**2**	**6**	**5**	**2**	**8**	**5**	***2***	***5***
Liquid Petroleum (LP) Gas	1	1%	1	2	*	1	1	2	*	1	*	*1*	*1*
Natural Gas	*	*	*	*	3	*	1	1	2	4	*	*	*
Oil	*	*	*	*	*	*	1	*	*	*	*	*	*
Unspecified Gas	1	1%	1	3	1	1	1	1	*	1	2	*	*2*
Unspecified Fuel	1	1%	*	*	*	*	2	1	*	1	2	*1*	*1*
Lanterns	**2**	**1%**	**4**	**6**	**3**	*****	**4**	**1**	*****	**2**	**2**	*****	***5***
Liquid Petroleum (LP) Gas	2	1%	4	6	3	*	4	1	*	1	2	*	*4*
Kerosene	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Unspecified Fuel	*	*	*	*	*	*	*	*	*	1	*	*	*
Grills, Camp Stoves	**2**	**1%**	**3**	*****	**2**	**2**	*****	*****	*****	**2**	*****	***1***	***6***
Kerosene	*	*	1	*	*	*	*	*	*	*	*	*	*
Liquid Petroleum (LP) Gas	1	1%	2	*	1	1	*	*	*	2	*	*	*2*
Wood	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Unspecified Fuel	1	1%	*	*	1	1	*	*	*	*	*	*1*	*2*
Other Products	**5**	**3%**	**3**	**3**	*****	**2**	**5**	**2**	**6**	**4**	**2**	***6***	***8***
Chimney – Unspecified Fuel	1	1%	*	1	*	*	*	*	*	*	1	*1*	*
Fireplace – Unspecified Gas	*	*	*	*	*	1	*	*	*	*	*	*	*
Fireplace – Wood	*	*	2	*	*	1	*	*	*	*	*	*	*
Fireplace – Coal	*	*	*	*	*	*	*	*	1	*	*	*	*
Other Products – LP Gas	2	1%	*	1	*	*	3	1	2	2	*	*1*	*4*
Other Products – Natural Gas	1	1 %	*	1	*	*	*	1	*	*	*	*3*	*1*
Other Products – Unspecified Gas	*	*	*	*	*	*	*	*	*	1	*	*	*
Other Products – Unspecified Fuel	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Unidentified Product	1	1%	1	*	*	*	*	*	2	1	1	*	*1*
Unidentified Product – LP Gas	< 1	< 1%	*	*	*	*	2	*	*	*	*	*	*1*
Multiple Products	**6**	**4%**	**7**	**12**	**8**	**20**	**12**	**11**	**15**	**8**	**5**	***5***	***7***

\+ Data collection for 2014 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, 2004–2014.

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, *Gas-Fueled Products* were associated with 79 of the 165 (48%) estimated CO fatalities in 2014. *Liquid-Fueled Products* were associated with 67 (41%) estimated fatalities, and *Solid-Fueled Products* were associated with 10 (6%) estimated fatalities in the same time period. An additional one (1%) fatality was associated with multiple products, where there were two or more different types of fuel used. Eight (5%) fatalities in 2014 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. For example, if an incident involved both a gasoline-fueled generator and a gasoline-fueled lawn mower, this incident would be included in the *Liquid-Fueled Products* category.

In the *Gas-Fueled Products* category, the majority of CO fatalities in 2014 were associated with heating-related products. Of the estimated 79 gas-fueled appliance fatalities in 2014, 58 (73%) were associated with heating systems or heaters, including furnaces, portable heaters, and room or space heaters. Additionally, all estimated five of the Multiple Gas-Fueled Products fatalities were associated with a heating-related products and some other product raising the total involving heating-related products to 63 of the 79 *Gas-Fueled Products* category (80%).

All but six of the estimated 67 liquid-fueled appliance-related fatalities in 2014 were associated with engine-driven tools (*e.g.*, generators, lawn mowers/garden tractors). Generators accounted for 54 of the estimated 67 fatalities (81%) in the *Liquid- Fueled Products* category for 2013. Additionally, an estimated one CO fatality was associated with portable generators and portable kerosene heater in an enclosed space.

In 2014, an estimated 10 fatalities occurred in the *Solid-Fueled Products* category. Seven of the estimated 10 fatalities were associated with charcoal or charcoal grills.

Table 2: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products Organized by Fuel Type, 2004–2014

	2013–*2014*+		Annual Estimates										
Consumer Product	**Average Estimate**	**Average Percent**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	***2014*+**
Total	**149**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	***146***	***165***
Gas-Fueled Products	**58**	**39%**	**87**	**53**	**51**	**80**	**58**	**53**	**70**	**58**	**51**	***45***	***79***
Natural Gas	**13**	**9%**	**32**	**10**	**26**	**30**	**28**	**17**	**23**	**15**	15	*13*	*11*
Furnace (incl. Boilers)	9	6%	23	6	19	20	18	10	15	6	15	*5*	*6*
Pool Heater	1	1%	*	1	*	*	*	*	*	*	*	*3*	*1*
Portable Heater	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Range/Oven	1	1%	2	1	*	2	*	2	2	3	*	*2*	*
Room/Space Heater	1	1%	6	*	1	*	3	2	*	*	*	*2*	*
Wall/Floor Furnace	1	1 %	1	2	2	5	3	1	2	*	*	*	*2*
Water Heater	*	*	*	*	3	*	1	1	2	4	*	*	*
Unspecified Heater	*	*	*	*	*	3	*	*	*	1	*	*	*
Other Appliance	*	*	*	*	*	*	*	1	*	*	*	*	*
Liquid Petroleum (LP) Gas	**31**	**21%**	**37**	**30**	**23**	**26**	**31**	**23**	**35**	**23**	**22**	***20***	***52***
Furnace (incl. Boilers)	5	3%	8	1	9	*	3	1	7	*	4	*1*	*11*
Generator	*	*	*	*	*	*	*	*	2	*	*	*	*
Grill/Camp Stove	1	1%	2	*	1	1	*	*	*	2	*	*	*2*
Lantern	2	1%	4	6	3	*	4	1	*	1	2	*	*4*
Other Products	1	1%	*	*	*	*	3	1	*	*	*	*	*2*
Pool Heater	*	*	*	*	*	*	*	*	1	*	*	*	*
Portable Heater	12	8%	15	19	10	14	9	8	18	11	10	*12*	*13*
Range/Oven	1	1%	1	1	*	1	*	*	1	1	1	*1*	*
Refrigerator	1	1%	*	1	*	*	*	*	1	2	*	*1*	*2*
Room/Space Heater	5	3%	*	*	*	4	3	5	1	1	4	*3*	*7*
Unspecified Heater/System	3	2%	*	*	*	1	3	*	1	3	1	*	*8*
Wall/Floor Furnace	*	*	5	*	*	4	1	5	1	*	*	*	*
Water Heater	1	1%	1	2	*	1	1	2	*	1	*	*1*	*1*
Unspecified Gas	**11**	**7%**	**15**	**11**	**1**	**11**	**3**	**5**	**6**	**17**	**10**	***13***	***11***
Furnace (incl. Boilers)	7	5%	5	2	*	4	2	1	4	10	4	*10*	*6*
Pool Heater	*	*	*	*	*	*	*	*	*	1	*	*	*
Portable Heater	*	*	1	1	*	*	*	*	*	*	*	*	*
Range/Oven	1	1%	1	3	*	3	*	2	1	3	2	*2*	*
Room/Space Heater	*	*	4	1	*	2	*	*	*	1	*	*	*
Fireplace	*	*	*	*	*	1	*	*	*	*	*	*	*
Wall/Floor Furnace	1	1%	*	*	*	*	*	*	*	*	*	*	*2*
Water Heater	1	1%	1	3	1	1	2	1	*	1	2	*	*2*
Unspecified Heater	< 1	< 1%	2	*	*	*	1	1	1	1	1	*	*

Table 2 (continued)

Consumer Product	2012–*2014*+ Average Estimate	2012–*2014*+ Average Percent	Annual Estimates 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Multiple Gas-Fueled Products	**3**	**2%**	**3**	**2**	**1**	**13**	**2**	**8**	**6**	**3**	**4**	*****	***5***
Liquid-Fueled Products	**68**	**46%**	**61**	**108**	**108**	**89**	**95**	**81**	**60**	**79**	**65**	***73***	***67***
Gasoline-Fueled	64	43%	**56**	**102**	**104**	**78**	**82**	**77**	**53**	**73**	**64**	***67***	***61***
Generator	55	37%	41	88	85	68	76	64	40	64	57	*55*	*54*
Other Engine-Driven Tools	9	6%	15	13	18	11	6	12	14	10	6	*13*	*7*
Kerosene-Fueled	**2**	**1%**	**5**	**2**	**3**	**3**	**4**	*****	**1**	**2**	**1**	*****	***4***
Grill/Camp Stove	*	*	1	*	*	*	*	*	*	*	*	*	*
Portable Heater	1	1%	4	2	3	3	4	*	1	2	1	*	*2*
Lantern	< 1%	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Oil-Fueled	**2**	**1%**	*****	**2**	*****	**5**	**2**	**3**	**1**	**2**	*****	***5***	***1***
Furnace (incl. Boilers)	2	1%	*	2	*	5	1	3	1	2	*	*5*	*1*
Water Heater	*	*	*	*	*	*	1	*	*	*	*	*	*
Wall/Floor Furnace	*	*	*	*	*	*	*	*	*	*	*	*	*
Diesel-Fueled	*****	*****	*****	*****	*****	*****	**1**	*****	*****	*****	*****	*****	*****
Water Heater	*	*	*	*	*	*	1	*	*	*	*	*	*
Multiple Liquid-Fueled Products	**1**	**1%**	*****	**2**	**1**	**2**	**5**	**1**	**5**	**1**	*****	***1***	***1***
Solid-Fueled Products	**10**	**7%**	**8**	**9**	**10**	**9**	**8**	**9**	**18**	**14**	**5**	***14***	***10***
Charcoal-Fueled	8	5%	**3**	**6**	**10**	**8**	**7**	**7**	**17**	**10**	5	*11*	*7*
Charcoal / Charcoal Grills	8	5%	3	6	10	8	7	7	17	10	5	*11*	*7*
Coal-Fueled	**1**	**1%**	**2**	**1**	*****	*****	*****	*****	**1**	**3**	*****	***1***	***1***
Furnace (incl. Boilers)	*	*	1	*	*	*	*	*	*	1	*	*	*
Room/Space Heater	1	1%	1	1	*	*	*	*	*	2	*	*1*	*1*
Chimney / Fireplace	*	*	*	*	*	*	*	*	1	*	*	*	*
Wood-Fueled	**1**	**1%**	**2**	**2**	*****	**1**	**1**	**2**	*****	**1**	*****	***2***	***1***
Chimney/Fireplace	*	*	2	*	*	1	*	*	*	*	*	*	*
Grill/Stove	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Room/Space Heater	1	1%	*	2	*	*	1	2	*	1	*	*2*	*

Table 2 (continued)

Consumer Product	2012–*2014*+ Average Estimate	2012–*2014*+ Average Percent	Annual Estimates 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Unspecified Fuel Products	**10**	**7%**	**9**	**12**	**6**	**2**	**11**	**3**	**7**	**9**	**11**	***10***	***8***
Chimney	1	1%	*	1	*	*	*	*	*	*	1	*1*	*
Furnace (incl. Boilers)	2	1%	6	3	2	*	5	1	2	2	5	*	*
Generator	1	1%	*	*	*	*	*	*	*	*	*	*1*	*1*
Grill/Camp Stove	1	1%	*	*	1	1	*	*	*	*	*	*1*	*2*
Lantern	*	*	*	*	*	*	*	*	*	1	*	*	*
Pool Heater	< 1	< 1%	*	*	*	*	*	*	*	*	*	*	*1*
Portable Heater	*	*	*	1	1	*	*	*	*	*	*	*	*
Range/Oven	2	1%	*	*	*	*	*	*	*	*	*	*5*	*
Room/Space Heater	< 1	< 1%	*	3	*	*	*	*	*	*	1	*	*
Unspecified Heater	1	1%	1	3	1	1	4	1	1	2	*	*1*	*1*
Wall/Floor Furnace	*	*	*	*	*	*	*	*	1	1	*	*	*
Unidentified Product	1	1%	1	*	*	*	*	*	2	1	1	*	*1*
Water Heater	1	1%	*	*	*	*	2	1	*	1	2	*1*	*1*
Multiple Product - Different Fuels	**3**	**2%**	**2**	**8**	**6**	**5**	**5**	**2**	**4**	**3**	**4**	***3***	***1***
Gas & Liquid	2	1%	2	7	6	5	3	1	1	2	2	*3*	*1*
Gas & Solid	< 1	< 1%	*	1	*	*	*	1	*	*	1	*	*
Liquid & Solid	*	*	*	*	*	*	1	*	2	1	*	*	*
Gas & Liquid & Unspecified	*	*	*	*	*	*	2	*	*	*	*	*	*

\+ Data collection for 2014 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, 2004–2014.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Table 3 shows a breakdown of the fatality estimates for the 11-year period from 2004 through 2014 in the *Engine-Driven Tools* category. During 2014, engine-driven tools were associated with an estimated 64 carbon monoxide poisoning deaths (39% of the 165 total consumer product estimate). Table 3 totals differ from those in Tables 1 and 2 in that they also includes the fatalities associated with multiple potential CO-producing products, where at least one product was an engine-driven tool. In 2014, there were an estimated two deaths associated with an engine-driven tool and some other fuel-burning product. An estimated 56 of the 64 engine-driven tool-related CO poisoning deaths (88%) 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, 2004–2014

Engine-Driven Tools	2012-*2014*+ Average Estimate	Average Percentage	Annual Estimate										
			2004	2005	2006	2007	2008+	2009	2010	2011	2012	2013	*2014*+
Total	**68**	**100%**	**59**	**110**	**106**	**85**	**93**	**78**	**61**	**78**	**66**	***73***	***64***
Generators	**56**	**82%**	**41**	**88**	**85**	**68**	**76**	**64**	**42**	**64**	**57**	***56***	***54***
Gasoline-fueled	55	82%	41	88	85	68	76	64	40	64	57	*55*	*53*
LP-fueled	*	*	*	*	*	*	*	*	**2**	*	*	*	*
Unspecified Fuel	1	1%	*	*	*	*	*	*	*	*	*	1	*1*
Other Engine-Driven Tools (OEDTs)	**9**	**13%**	**15**	**13**	**17**	**11**	**6**	**12**	**14**	**10**	**6**	***13***	***7***
Lawn Mowers	**4**	**6%**	**8**	**9**	**11**	**5**	**2**	**6**	**7**	**3**	**4**	***7***	***1***
Riding Mowers	3	4%	5	9	8	4	2	6	5	3	2	*6*	*
Walk Behind Mowers	*	*	1	*	*	*	*	*	*	*	*	*	*
Unspecified Mowers	1	1%	1	*	3	1	*	*	2	*	1	*1*	*1*
Paint Sprayer	*	*	*	*	*	*	*	*	*	1	*	*	*
Power Washer	1	1%	2	3	1	1	*	1	*	2	*	*	*2*
Snow Blower/Thrower	1	1%	1	*	1	2	*	3	1	1	*	*2*	*1*
ATV	1	1%	1	1	*	*	2	*	4	2	1	*1*	*1*
Water Pump	< 1	< 1%	1	*	1	1	*	*	1	*	*	*1*	*
Welder	*	*	*	*	*	1	1	*	*	*	*	*	*
Air Compressor	*	*	1	*	1	*	*	*	*	*	*	*	*
Concrete Saw	*	*	1	*	*	*	1	*	*	*	*	*	*
Tiller	*	*	*	*	*	*	*	1	*	*	*	*	*
Go-Cart	*	*	*	*	*	*	*	1	*	*	*	*	*
Small Engine	*	*	*	*	1	*	*	*	*	*	*	*	*
Snowmobile	*	*	*	*	1	*	*	*	*	*	*	*	*
Stump Grinder	< 1	< 1%	*	*	*	*	*	*	*	*	*	*1*	*
Wood Splitter	1	1%	*	*	*	*	*	*	*	*	1	*	*1*
Multiple Product: Engine-Driven Tools Involved	**3**	**4%**	**3**	**9**	**3**	**6**	**10**	**2**	**6**	**4**	**2**	***5***	***2***
Generator + OEDT	*	*	*	*	*	*	*	*	*	*	*	*	*
Generator + other Product	2	3%	2	9	3	6	8	2	6	3	2	*3*	*2*
Multiple OEDT	*	*	*	*	*	*	2	*	*	1	*	*	*
OEDT + other product	< 1	< 1%	1	*	*	*	*	*	*	*	*	*1*	*

\+ Data collection for 2014 is only partially complete, and data are shown in italics. Italicized estimates may change in the future if more reports of fatalities are received.

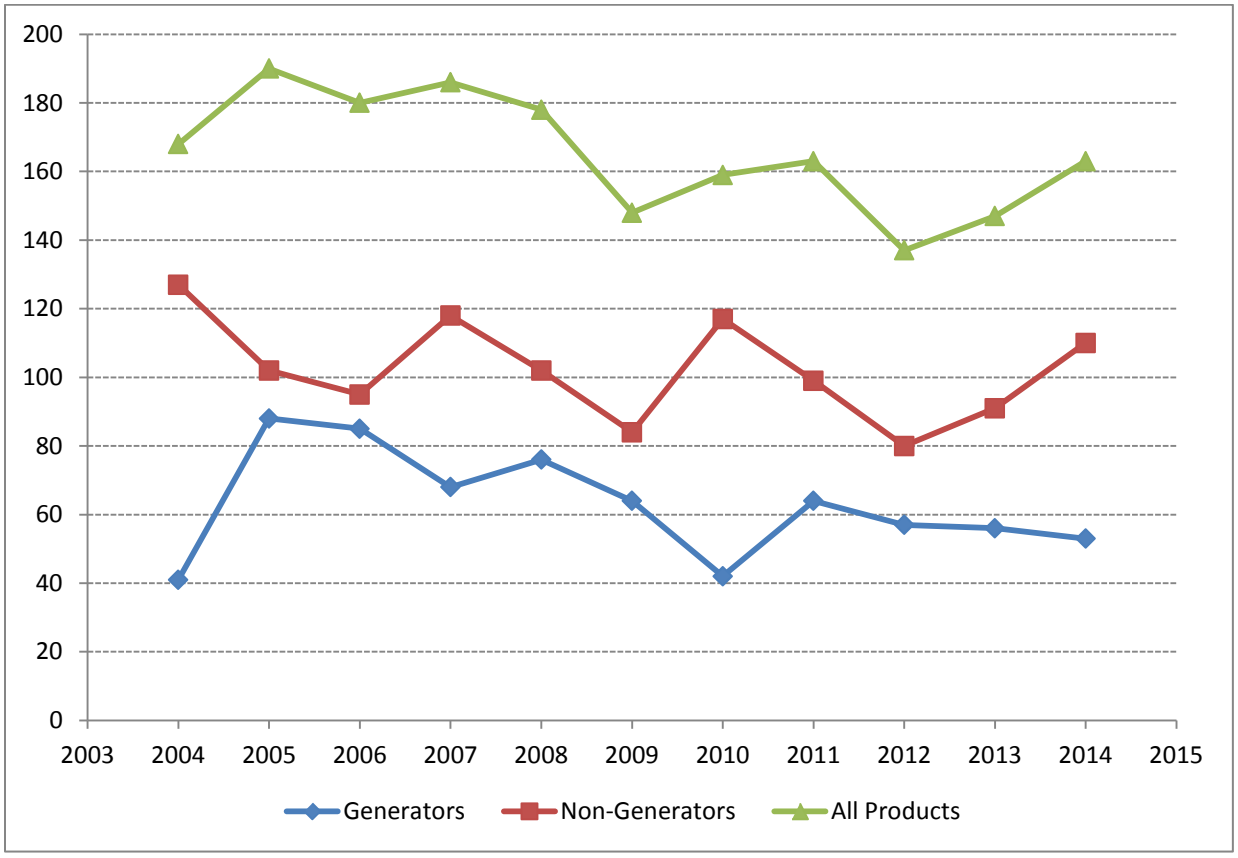
* No reports received by CPSC staff.

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, 2004–2014.

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 2004 to 2014 indicates that there is statistically significant evidence of a downward trend (p-value = 0.0221). However, it should be noted that the estimated number of consumer product-related CO fatalities in the most current year (2014) was greater than any of the previous five years. In addition, due to reporting delays, national estimates for recent years, especially 2014, most likely will likely change (usually upward) by a small amount in subsequent reports. For example, the estimated fatalities, based on new additional data, for 2013 were revised up from the estimated 144 deaths in last year's report to 146 in this year's report.

Figure 1: Comparison of Trends in Consumer Product-Related Carbon Monoxide Deaths–2004 to 2014



Lawnmowers were associated with 51 percent (63 of 124) of the deaths in the *Other Engine-Driven Tools* category for the 11-year period. There were five other fatalities associated with a lawnmower and another product in this period. There was an estimated average of four lawnmower-related CO fatalities per year from 2012 to 2014 (12 deaths, excluding multi-product deaths). CO fatalities related to ATV exhaust were in the next largest subcategory, with an estimated 13 deaths from 2004 to 2014 and nine occurring during the five most recent years of this report (between 2010 through 2014). Additionally, snow blowers/throwers and power washers were each associated with 12 CO fatalities over the 11-year period.

Table 4 shows that in 2014, 83 of the 107 fatal CO incidents (78% of fatal CO incidents reported to the CPSC) involved a single death. Table 4 accounts for only the fatally injured victims in each CO poisoning incident. It is not uncommon for CO incidents involving one or more fatalities to also result in one or more nonfatal CO poisoning injuries. However, the breakdown of these incidents was not quantified for analysis in this report. It should be noted that these are counts of incidents reported in CPSC databases and do not represent the national estimates of fatalities per CO incident. The estimates presented elsewhere in this report are based on the number of death certificates for which CPSC has records, scaled to adjust for missing records. Therefore, the counts presented in Table 4 should not be expected to add up to the estimated fatalities in other tables. Additionally, note that occasionally, even though CPSC records indicate that there was more than one fatality in a specific incident, not all the fatalities are used in the estimation process. Fatalities for which CPSC does not have a death certificate are not used in the analyses, because the scaling estimation process accounts for missing records. Additionally, if an additional fatality that is work related is indicated in the record, that fatality was not counted in the estimation process, because work-related fatalities are out of scope for this report. However, both of these cases are included in Table 4 to highlight the danger of multiple fatalities in CO poisoning cases.

Death certificates do not include information about other fatalities for the same incident. The number of fatalities for a particular incident is based primarily on CPSC In-Depth Investigation (IDI) records. Some additional multiple-fatality incidents were identified by matching the 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 (246 of 1,340 incidents) resulted in multiple fatalities, including 15 incidents resulting in four or more CO fatalities.

Table 4: Number of Carbon Monoxide Poisoning Incidents Reported to CPSC by Number of Deaths per Incident, 2004–2014

Number of Deaths Reported in Incident	2012–*2014*+		Annual Incidents										
	Annual Average	Average Percent	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Total Incidents	**105**	**100%**	**127**	**146**	**123**	**147**	**141**	**117**	**116**	**120**	**90**	**106**	***107***
1	84	80%	105	123	93	125	119	93	100	95	74	84	*83*
2	19	18%	14	17	22	13	15	19	14	22	14	21	*21*
3	1	1%	7	5	6	8	5	4	1	1	1	*	*1*
4	1	1%	1	*	1	1	2	1	1	1	*	1	*1*
5	1	1%	*	*	1	*	*	*	*	1	1	*	*1*
6	*	*	*	1	*	*	*	*	*	*	*	*	*

+ Data collection for 2014 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.

Numbers presented here are counts based on records available to CPSC staff. These do not represent national estimates and should not be expected to match estimates presented elsewhere in this document.

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

Table 5 shows that, in 2014, an estimated 130 CO poisoning deaths occurred in home locations, including an estimated fifteen deaths in detached structures at residential locations (*i.e.*, sheds, detached garages) and twelve in structures not intended originally as a permanent

residence (*i.e.*, camper trailers, sea-land shipping containers). From 2012 to 2014, an annual average of 121 CO poisoning deaths (81% of all CO fatalities) occurred at home locations. In 2014, an estimated 22 deaths took place in temporary shelters, such as campers, cabins, and trailers used for shelter. For 2012 to 2014, an annual average of 20 CO poisoning deaths (13%) took place in temporary shelters. Deaths due to CO poisoning in temporary shelters were most commonly associated with heating sources, generators, or lanterns.

A small percentage of deaths due to CO poisoning involving a consumer product occurred in vehicles, such as passenger vans, trucks, automobiles, or boats where a consumer product was the CO producing product in use. In 2014, there were an estimated five CO fatalities in this category. For the 3-year period 2012 to 2014, an annual average of four CO poisoning deaths (3%) took place in vehicles. All of the vehicle location incidents in this 3-year period involved a generator, LP heater, LP lantern, or the burning of charcoal inside the vehicle.

Table 5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Location of Death, 2004−2014

	2012−*2014*+		Annual Estimate										
Location of Death	**Average Estimate**	**Average Percent**	**2004**	**2005**	**2006**	**2007**	***2008***	**2009**	**2010**	**2011**	**2012**	**2013**	***2014***+
Total	**149**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
Home[1]	105	70%	121	120	119	138	124	109	125	122	107	104	*103*
Home – External Structure[2]	11	7%	10	16	14	11	13	7	5	10	5	13	*15*
Home – But Not House[3]	5	3%	*	6	4	4	6	1	5	5	1	3	*12*
Temporary Shelter	20	13%	22	32	36	22	20	18	17	15	21	16	*22*
Vehicles (including boats)	4	3%	8	14	6	8	9	12	6	9	*	7	*5*
Other	3	2%	8	2	1	2	3	*	1	1	*	2	*7*
Unknown	1	1%	*	*	*	*	2	*	*	1	2	*	*1*

\+ Data collection for 2014 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, 2004–2014.

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 2014, nearly half of the 165 estimated CO fatalities (82, 50%) were attributable to incidents that occurred during the four cold months of November, December, January, and February. An estimated 44 fatalities (27%) are attributable to incidents that occurred during the transition months of March, April, September, and October; and an estimated 39 fatalities (24%) are attributable to the warm months of May, June, July, and August. Over the 11 years that this

report spans, an estimated 57 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 15 percent of fatalities occurred in the warm months.

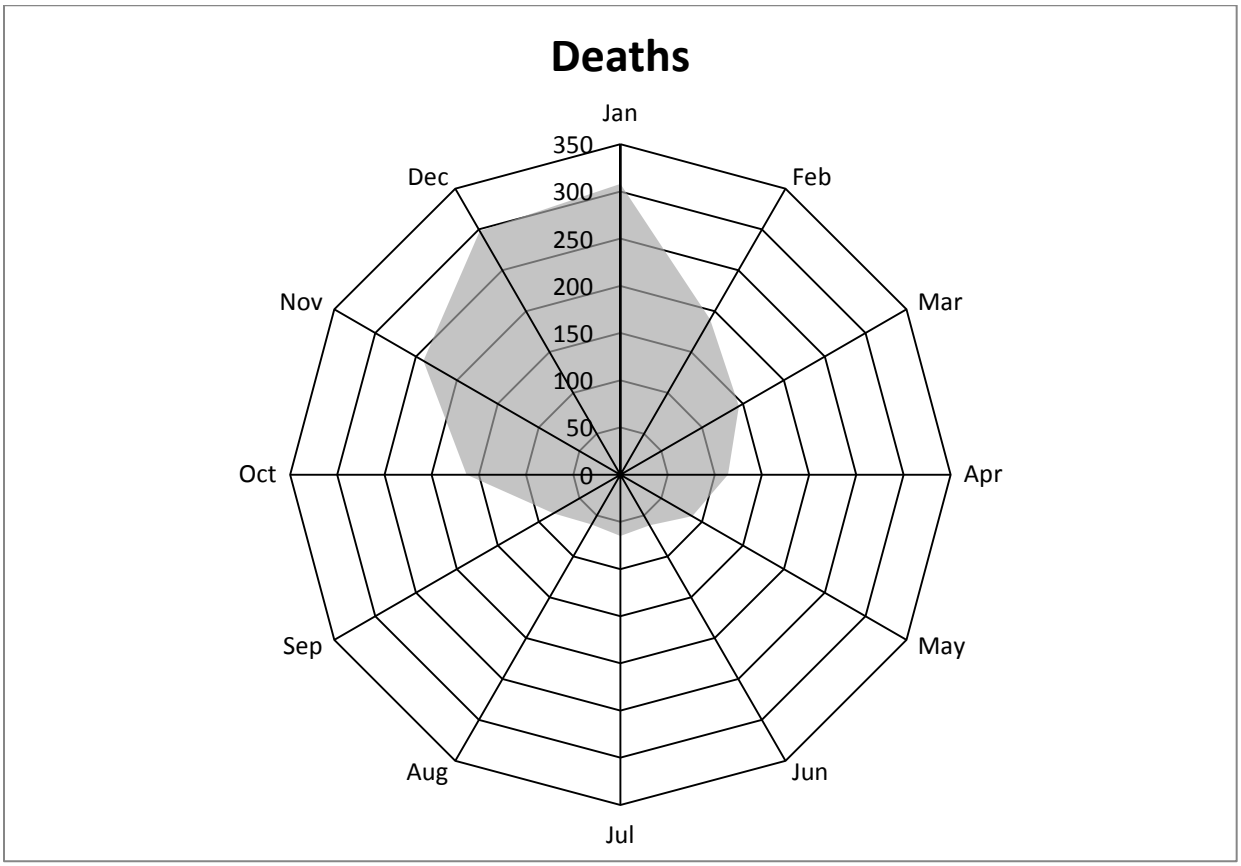
Table 6: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Month and Year of the Fatality, 2004–2014

Month of Death	2012–*2014*+		Annual Estimate										
	Average Estimate	Average Percent	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Total	**149**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
Cold Months	**80**	**54%**	**107**	**98**	**95**	**109**	**110**	**85**	**109**	**85**	**75**	**82**	***82***
November	20	13%	26	18	23	21	28	12	18	34	26	16	*19*
December	24	16%	27	33	38	25	25	20	38	20	25	28	*19*
January	20	13%	34	37	14	43	31	29	38	24	10	22	*27*
February	16	11%	20	10	20	20	26	24	15	8	14	16	*17*
Transition Months	**44**	**30%**	**41**	**62**	**56**	**49**	**34**	**41**	**33**	**55**	**46**	**43**	***44***
March	9	6%	10	19	19	19	7	12	22	9	6	12	*10*
April	12	8%	8	9	16	15	7	8	6	11	14	6	*15*
September	6	4%	14	17	7	1	7	4	2	13	6	5	*6*
October	18	12%	9	17	14	14	13	17	2	23	20	21	*13*
Warm Months	**25**	**17%**	**19**	**31**	**29**	**29**	**32**	**21**	**17**	**23**	**16**	**21**	***39***
May	8	5%	5	4	9	9	16	5	8	8	2	4	*17*
June	5	3%	6	9	3	4	8	10	5	2	5	6	*4*
July	9	6%	4	12	4	5	3	4	2	4	7	7	*13*
August	4	3%	4	6	13	11	5	2	1	8	1	5	*5*

\+ Data collection for 2013 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, 2004– 2014.
Note: Reported annual estimates and estimated averages and percentages may not add to subtotals or totals due to rounding.

Figure 2 graphically 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 2004 through 2014, 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, 2004–2014



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 (2004–2014). From the data, it appears that consumer product-related CO fatalities are skewed toward older individuals. For the three most recent years (2012–2014), children younger than 15 years of age accounted for an annual average of 4 percent (an estimated 6 of 149) 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 66 percent (98 of 149) in 2012 to 2014, while only about 39 percent of the U.S. population is over 45 years old. In 2012 to 2014, adults age 65 years and older accounted for an annual average percentage of 24 percent of CO poisoning fatalities, nearly 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 from 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 (0.0024);
3. The "45–64" group was significantly higher (< 0.0001); and
4. The "65 and older" group was significantly higher (< 0.0001).

Table 7: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Age of Victim, 2004–2014

Age	2012–*2014*+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Total	**149**	**100%**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
Under 5	1	1%	6%	3	*	2	8	2	3	1	*	1	*	*2*
5 - 14	5	3%	13%	11	7	4	6	8	2	1	4	4	5	*7*
15 - 24	8	5%	14%	4	17	21	18	15	14	12	9	6	11	*8*
25 - 44	36	24%	27%	43	46	59	34	54	43	39	36	37	34	*38*
45 - 64	62	42%	26%	68	86	58	70	68	59	69	63	56	62	*68*
65 and over	36	24%	13%	39	34	36	49	30	27	36	52	32	36	*41*

+ Data collection for 2014 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 3- year average (2012-2014). U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates

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, 2004 - 2014.

U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Release Date: May 2013; U.S. Census Bureau, 2009-2013 American Community Survey 5-Year Estimates, Release Date: May 2014; U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates, Release Date: May 2015

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

[7] Three-year average, 2012 to 2014 from June 2016 U.S. Census estimates of the U.S. population.

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

Table 8 presents the distribution of estimated CO fatalities categorized by gender. In 2014, 77 percent of CO poisoning victims were males, and 23 percent were females. These percentages varied slightly from year to year over the 11 years of this report. However, every year there are many more male CO fatalities than female. Over the years, 2012 through 2014, the average percentage of male CO victims was also 77 percent, and the average percentage of female victims was 23 percent. By contrast, about 49 percent of the U.S. population is male, and 51 percent of the U.S. population is 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, 2004-2014

Gender	2012–*2014*+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
Total	**149**	**100%**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
Male	**115**	**77%**	49%	123	140	145	132	140	109	121	111	92	124	*128*
Female	**35**	**23%**	51%	45	50	36	53	36	39	38	52	45	22	*38*

+ Data collection for 2014 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 3-year average (2012-2014).

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, 2004–2014.

U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Release Date: May 2013; U.S. Census Bureau, 2009-2013 American Community Survey 5-Year Estimates, Release Date: May 2014; U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates, Release Date: May 2015

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 2004 through 2014. 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.

The estimated percentage of the 2012–2014 annual average of non-Hispanic white CO fatalities closely mirrors the percentage of the U.S. population[10] at 62 percent and 63 percent, respectively. However, there appears to be a disproportionate number of Black or African American victims of CO poisoning, comprising 21 percent of all CO poisoning fatalities, even though Blacks or African Americans represent only about 12 percent of the U.S. population. By contrast, the proportion of the CO poisoning fatality victims who were of Hispanic ethnicity (9%) is below the percentage of Hispanics in the U.S. population (17%). Chi-square goodness-of-fit test results indicate that there is a significant statistical difference (p-value = 0.0021) 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

[9] Three-year average, 2012 to 2014, from June 2016 U.S. Census estimates of the U.S. population.

[10] The "percentage of the U.S. population" is defined here as the 3-year average, 2012 to 2014 of the June 2016 U.S. Census estimates of the U.S. population.

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 0.0135) 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. 0009) 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, 2004−2014

Race/Ethnicity	2012−2014+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2004	2005	2006	2007	2008	2009	2010	*2011*	2012	2013	*2014+*
Total	**149**	**100%**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
White (non-Hispanic)	**92**	**62%**	63%	116	134	107	122	122	93	82	106	82	86	*108*
Black or African American	**31**	**21%**	12%	27	36	36	35	30	20	43	38	31	35	*27*
Hispanic (All races)	**14**	**9%**	17%	20	15	19	23	14	11	18	9	11	13	*18*
Asian / Pacific[1]	**6**	**4%**	5%	2	2	13	3	1	3	4	3	5	7	*6*
American Indian[2]	**1**	**1%**	1%	*	*	6	1	5	1	5	1	*	1	*1*
Unknown / Other / Mixed[3]	**6**	**4%**	2%	2	2	*	2	4	19	8	6	7	5	*5*

\+ Data collection for 2014 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 3-year average (2012-2014).

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, 2004–2014.
U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Release Date: May 2013; U.S. Census Bureau, 2009-2013 American Community Survey 5-Year Estimates, Release Date: May 2014; U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates, Release Date: May 2015

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

Table 10 provides a breakout of the CO poisoning fatalities characterized by population density of the incident location. The table is presented as three sections: (1) incidents occurring at all incident locations; (2) incidents occurring in locations identified as a permanent home (*e.g.*, house, apartment, mobile home); and (3) incidents occurring only in non-home locations (*e.g.*, camper trailer, tent, motel room). Please note that "Home Locations" and "Non-Home Locations" sum to "All Locations."

All fatal incidents were designated as occurring in one of four rural/urban categories based on the Rural-Urban Commuting Area (RUCA) codes developed by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) 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 HHS/HRSA Office of Rural Health Policy and the USDA Economic Research Service. 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 2012 through 2014, in urban locations (53%), is smaller than the percentage of the U.S. population living in urban core locations (73%). The difference is offset by the larger percentages in the other three categories: sub-urban locations (19% versus 15% of the U.S. population), large rural town locations (9% versus 6%), and small town/rural isolated locations (17% 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 (3%) could not be ascertained. However, looking at the *Non-Home Locations* category may help to identify some of the disparity for each of the non-urban location categories. An average of 32 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 2012 through 2014, an estimated average of 9 of 28 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 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.

[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.

Table 10: Estimated Non-Fire Carbon Monoxide Poisoning Deaths by Population Density of Place of Death, 2004–2014

RUCA Population Density Designation	2011–*2013*+		Estimated Percentage of U.S. Population#	Annual Estimate										
	Average Estimate	Average Percent		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*2014*+
All Locations	**149**	**100%**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	**146**	***165***
Urban Core	79	53%	73%	95	91	112	114	105	78	94	95	79	84	*74*
Sub-Urban	28	19%	15%	30	53	28	31	32	42	33	33	25	27	*33*
Large Rural Town	13	9%	6%	20	15	17	12	23	10	25	14	9	12	*19*
Small Town/ Rural Isolated	25	17%	5%	23	31	23	28	17	18	7	18	19	23	*33*
Unknown Location	4	3%	-	*	*	*	*	*	*	*	2	6	1	*6*
Home Locations	**121**	**100%**	**100%**	**131**	**141**	**138**	**153**	**143**	**117**	**135**	**137**	**113**	**121**	***130***
Urban Core	70	58%	73%	79	74	99	96	89	66	88	78	71	73	*65*
Sub-Urban	24	20%	15%	23	32	19	22	27	30	24	28	20	24	*28*
Large Rural Town	9	7%	6%	16	14	13	11	16	10	19	14	6	7	*15*
Small Town/ Rural Isolated	16	13%	5%	13	21	7	24	11	11	4	15	11	15	*22*
Unknown Location	2	2%	-	*	*	*	*	*	*	*	2	5	1	*
Non-Home Locations	**28**	**100%**	**100%**	**37**	**49**	**42**	**32**	**34**	**30**	**24**	**26**	**24**	**26**	***35***
Urban Core	9	32%	73%	15	17	13	18	16	11	6	18	7	11	*8*
Sub-Urban	4	14%	15%	8	21	9	9	5	12	8	5	5	2	*5*
Large Rural Town	4	14%	6%	4	1	3	1	7	*	6	*	2	5	*5*
Small Town/ Rural Isolated	9	32%	5%	10	10	17	4	6	7	4	3	7	8	*11*
Unknown Location	2	7%	-	*	*	*	*	*	*	*	*	1	*	*6*

+ Data collection for 2014 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, 2004–2014.
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, 2004–2014

Region‡	2012–*2014*+		Estimated Percentage of US Population#	Annual Estimates										
	Average Estimate	Average Percent		2004	2005	2006	2007	2008	2009	2010	2011	2012	*2013*+	*2013*+
Total	**149**	**100%**	**100%**	**168**	**190**	**180**	**186**	**178**	**148**	**159**	**163**	**137**	***146***	***165***
Northeast	**31**	**21%**	**18%**	**16**	**33**	**24**	**44**	**28**	**14**	**23**	**43**	**25**	***34***	***34***
New England	8	5%	5%	7	7	8	10	12	5	5	16	1	*14*	*8*
Middle Atlantic	23	15%	13%	10	26	16	34	16	9	18	27	24	*20*	*26*
South	**48**	**32%**	**37%**	**58**	**74**	**57**	**61**	**51**	**55**	**55**	**55**	**55**	***43***	***45***
East South Central	7	5%	6%	16	9	10	9	10	19	12	13	7	*3*	*10*
South Atlantic	24	16%	20%	21	41	26	25	21	13	26	23	31	*20*	*22*
West South Central	17	11%	12%	21	24	21	27	21	23	17	19	17	*20*	*13*
Midwest	**40**	**27%**	**21%**	**49**	**46**	**54**	**47**	**58**	**48**	**49**	**33**	**31**	***48***	***41***
East North Central	25	17%	15%	30	31	40	25	39	28	40	27	26	*27*	*23*
West North Central	15	10%	7%	19	15	14	22	18	20	10	6	5	*21*	*18*
West	**31**	**21%**	**24%**	**37**	**33**	**46**	**33**	**40**	**31**	**31**	**32**	**25**	***23***	***45***
Mountain	16	11%	7%	20	18	21	17	25	16	11	9	13	*9*	*27*
Pacific	15	10%	16%	16	15	24	17	15	14	20	23	12	*14*	*18*

‡ 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 2014 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 (2012-2014).

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, 2004–2014.

Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014, U.S. Census Bureau, Population Division, .Release Date: May 2015.

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 the report concentrates on deaths coded as X47 and Y17. Code X67, which 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 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. For 2007, three more cases were reclassified. For 2008, 2009, 2010, and 2011, no ABDT records were reclassified as in scope. For the three most recent years, eight cases were reclassified: three cases for 2012; one case for 2013; and four cases for 2014.

Since the release of the previous annual report, additional records have been entered into the CPSC databases; and therefore, the resulting initial categorization for 2013 through 2014 has been recalculated and is presented in Tables A.1.a through A.1.b.

Table A.1.a: Initial Categorization for 2013 Data

ICD-10 Code	NCHS Total	DTHS File & ABDT File				Number of Cases to be Imputed[1]
		In-Scope	Unknown Scope	Out-of-Scope	Total	
X47	704	123	18	485	626	96
Y17	76	3	3	57	63	16
Total	**780**	**126**	**21**	**542**	**689**	**112**

Table A.1.b: Initial Categorization for 2014 Data

ICD-10 Code	NCHS Total	DTHS File				Number of Cases to be Imputed[2]
		In-Scope	Unknown Scope	Out-of-Scope	Total	
X47	803	135	18	528	681	140
Y17	106	1	10	60	71	45
Total	**909**	**136**	**28**	**588**	**752**	**185**

1 "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, 2013–2014.

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 two death certificate files 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 2013 and 2014 estimates of CO poisoning deaths.

Table A.2.a: Calculation Detail of the Final Computed 2013 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
$\mathbf{n_1}$	123	3
$\mathbf{n_2}$	626 - 18 = 608	63 - 3 = 60
$\mathbf{n_3}$	704	76
Weighting Factor (n_3 / n_2)	1.1579	1.2667
N	142.4211	3.8000
Total Estimate	{142.4211 + 3.8000 = 146.2211 ~ 146}	

Source: U.S. Consumer Product Safety Commission/EPHA.
CPSC Death Certificate File, CPSC In-Depth Investigation File, Abbreviated Death Certificate File, National Center for Health Statistics Mortality File, 2013-2014.

Table A.2.b: Calculation Detail of the Final Computed 2014 Estimate of Non-Fire CO Poisoning Deaths Associated with Consumer Products

Variable	ICD-10 Code	
	X47	**Y17**
$\mathbf{n_1}$	135	1
$\mathbf{n_2}$	681 - 18 = 663	71 - 10 = 61
$\mathbf{n_3}$	803	106
Weighting Factor (n_3 / n_2)	1.2112	1.7377
N	163.5068	1.7377
Total Estimate	{163.5068 + 1.7377 = 165.2445 ~ 165}	

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, 2013-2014.

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. CPSC staff has no way of correcting CPSC records to mesh with NCHS records. CPSC receives death certificate facsimiles or electronic death certificates directly from the states, and those death certificates have not been corrected per NCHS procedures. As a consequence, there may be slight discrepancies between final NCHS counts and CPSC records, because CPSC records do not reflect NCHS changes in ICD-10 codes on death certificates. 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 to codes other than X47 or Y17 thereby having little long-term effect on the estimates.

Table A.3 shows the weighting factors used to calculate the estimates for the years 2004–2014, 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 2004–2014

Year	NCHS Total	Total in CPSC Databases*	In-Scope Cases+	Weighting Factor
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	591	109	1.2453
Y17	114	84	1	1.3571
2013				
X47	704	608	123	1.1579
Y17	76	60	3	1.2667
2014				
X47	803	663	135	1.2112
Y17	106	61	1	1.7377

\+ 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, 2004–2014.

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.

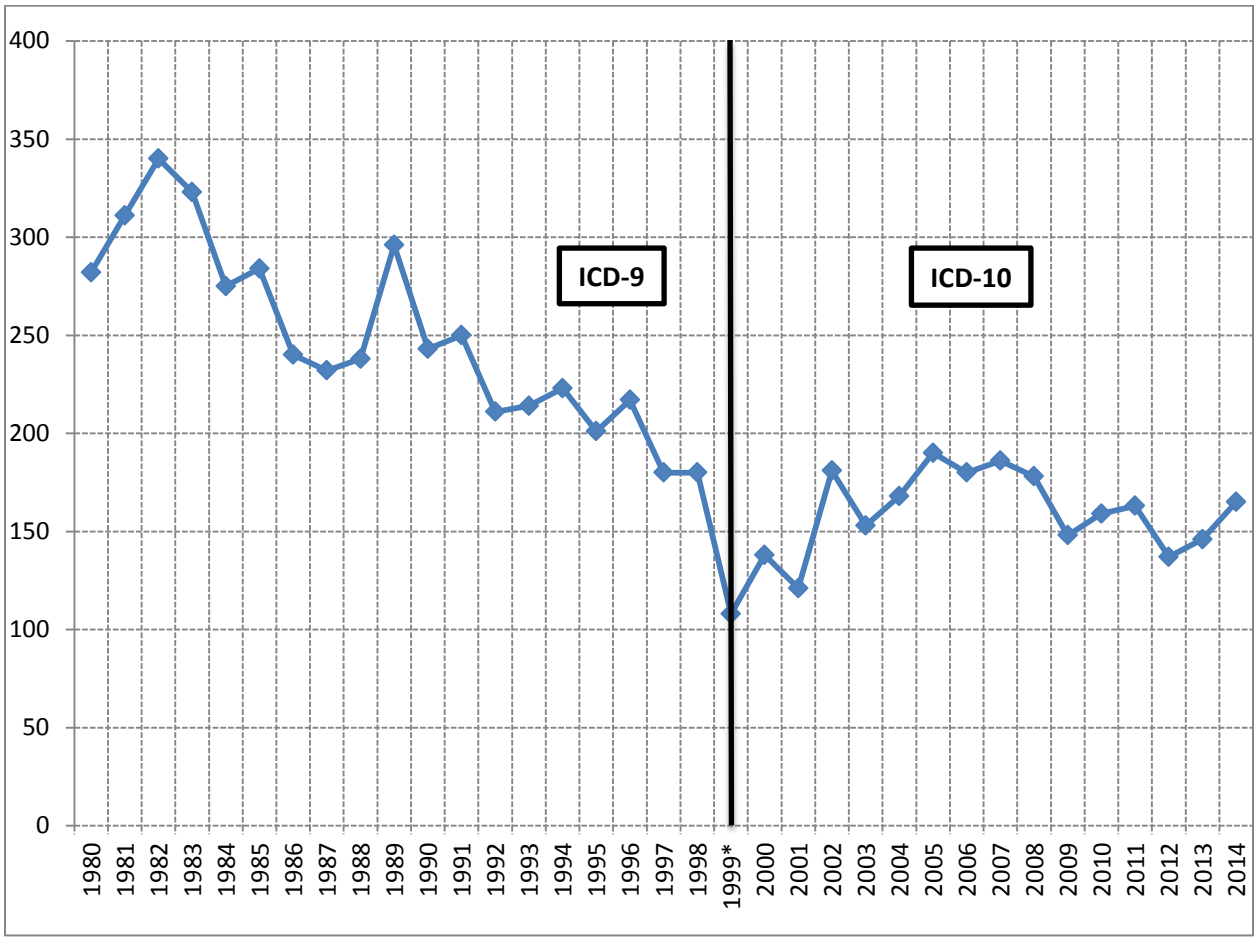
Reports of non-fire CO poisoning deaths were retrieved from the DTHS and ABDT files based on the following criteria: date of death between 1/1/2004 and 12/31/2014, and ICD-10 code of X47 or Y17. Death certificates entered into the CPSC's database before August 1, 2017, were included in this analysis. 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 because they are outside the jurisdiction of the CPSC.

Appendix B: National Estimates of Consumer Product-Related CO Poisoning Deaths, 1980 to 2014

Figure B.1 below graphically suggests a trend of the estimated CO fatalities from 1980 to 2014. 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: 1980–2014



* Implementation of ICD-10.

Table B.1 presents the annual estimates from 1980 to 2014, and the 3-year average mortality rates associated with each year, where three 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 increased annually through 2006, to a rate of 6.21. Since 2006, the rate has been slowly dropping to the current 2013 estimate of 4.72. The year 2013 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, 1980−2014

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	5.61
2009	148	307,007	5.27
2010	159	309,347	5.06
2011	163	311,722	4.91
2012	137	314,112	4.73
2013	146	316,498	4.72
2014	165	318,857	

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, 2015

Before implementation of ICD-10 in 1999, generating 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. Since 2006, the 3-year average mortality rate decreased slowly to 2011 where the 3-year average mortality rate reached 1.74. However, the 3-year average mortality rate from 2010 to 2013 appears to be fluctuating between a 1.70 rate and a 1.90 rate. However, this 3-year average mortality rate range 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*, 1999−2014

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	2.53
2008	76	304,375	2.28
2009	64	307,007	1.98
2010	42	309,347	1.83
2011	64	311,722	1.74
2012	57	314,112	1.88
2013	56	316,498	1.77
2014	55	318,857	

* 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 2013, 3-year average mortality rate was 2.77, a decrease of 23 percent. From 2008 through 2011, the 3-year averages did not change much, hovering in the 2.86 to 2.88 range after dropping from a 2003 high of 3.93. In 2012, the non-generator consumer product CO fatality rate dropped to 2.66 per 10 million, the lowest rate over the period of this report. However, the 2013 rate increased 2.77 per 10 million population.

Table B.3: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999–2014 (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	2.86
2009	73	307,007	2.88
2010	102	309,347	2.87
2011	91	311,722	2.87
2012	75	314,112	2.66
2013	85	316,498	2.77
2014	103	318,857	

* 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 2012. Though the average mortality rates for 2007 through 2011 have dropped slightly since the 2006 high (3.18), in 2012 there was a slight uptick from 2011 (2.06) to 2.15. The rate stayed the same in 2013. The table shows that the average mortality rate tripled from the 2000 3-year average rate (0.72), to the average rate for 2013 (2.15).

Table B.4: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Generators and Other Engine-Driven Tools, 1999–2014*

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	2.93
2008	82	304,375	2.60
2009	76	307,007	2.32
2010	56	309,347	2.21
2011	73	311,722	2.06
2012	64	314,112	2.15
2013	68	316,498	2.15
2014	62	318,857	

* 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 27 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 2.50 in 2013.

Table B.5: Estimated Non-Fire Carbon Monoxide Poisoning Deaths Associated with Consumer Products, 1999−2014* (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	2.54
2009	61	307,007	2.53
2010	88	309,347	2.49
2011	82	311,722	2.54
2012	68	314,112	2.37
2013	73	316,498	2.50
2014	96	318,857	

* 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.

Summary: When all consumer products are included, there has been a 9 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 4.72 in 2013, 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.

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
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