UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
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BETHESDA, MD 20814

This document has been electronically approved and signed.

Memorandum

June 1, 2011

TO: The Commission
Todd A. Stevenson, Secretary

THROUGH: Cheryl A. Falvey, General Counsel
Kenneth R. Hinson, Executive Director

FROM : Robert J. Howell, Assistant Executive Director
Office of Hazard Identification and Reduction
Allyson Tenney, Project Manager
Directorate for Engineering Sciences

SUBJECT: Status Report on Candle Standards Development Activities

Introduction

On March 10, 2004, a request to the U.S. Consumer Product Safety Commission (CPSC) from the National Association of State Fire Marshals (NASFM) to issue mandatory standards for candles and candle accessories was docketed as a petition, CP 04-1/HP 04-1. CPSC staff sent an options briefing package[1] to the Commission on July 10, 2006, recommending that the Commission defer a decision on the petition from NASFM. Staff noted that deferring a decision on the petition would provide staff with additional time to continue working with ASTM International (ASTM) in developing voluntary consensus standards for candle products and to assess the impact of the ASTM standards.

The Commission voted on July 19, 2006, to defer the petition as recommended by staff. Staff was directed by the Commission to continue working with ASTM in developing standards for candle products and to provide periodic status updates on the development of the standards to the Commission. The first status report was provided to the Commission on June 6, 2007.[2] This is the second status report on candle standards development activities. It provides a discussion of the most recent available incident data and also provides a summary of current industry activities and compliance actions.

[1] Staff Briefing Package--*Options to Address Petition from National Association of State Fire Marshals (NASFM) Requesting Mandatory Candle Standards*, submitted to the Commission on July 10, 2006 (available from Office of the Secretary or www.cpsc.gov, specifically at http://www.cpsc.gov/library/foia/foia06/brief/candleballot.pdf).
[2] Status Report, June 6, 2007, available from Office of the Secretary or www.cpsc.gov, specifically at http://www.cpsc.gov/library/foia/foia07/brief/candle.pdf).

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ASTM International Standards

In 1997, CPSC staff requested ASTM Subcommittee F15.45--*Candle Products* to develop voluntary performance standards for candles to reduce fire hazards associated with candle products. Several task groups were formed within ASTM Subcommittee F15.45 to develop new voluntary standards for candle products. Task group members include candle manufacturers, suppliers, retailers, test laboratories, and representatives from the different candle-related trade associations, including the National Candle Association (NCA). The task groups were assigned specifically to address Terminology, Labeling, Data Evaluation, Glass Containers, Smoking, Wicks, and Fire Safety. To date, there are six published ASTM standards relating to candles and candle products, listed in Table 1. Future work of the task groups includes

ASTM Designation	Title	Description	Status
ASTM F 1972-05	Standard Guide for Terminology Relating to Candles and Associated Accessory Items	Defines standard terms used to describe candles and candle products	Originally published in 1999; formal review completed in 2005
ASTM F 2058-07	Standard Specification for Candle Fire Safety Labeling	Specifies cautionary labeling information for candles and candle products	Originally published in 2000; revised version published in 2007
ASTM F 2179-02 (2007)	Standard Specification for Annealed Soda-Lime-Silicate Glass Containers That Are Produced for Use as Candle Containers	Specifies performance requirements to prevent glass candle containers from shattering	Originally published in 2002; reapproved in 2007
ASTM F 2326-04 (2009)	Standard Test Method for Collection and Analysis of Visible Emissions from Candles as they Burn	Provides test method to evaluate visible emissions from indoor candle use	Originally published in 2004; reapproved in 2009
ASTM F 2417-09	Standard Specification for Fire Safety for Candles	Prescribes candle performance requirements (stability, flame height, secondary ignition, and end-of-life behavior)	Originally published in 2004; revised version published in 2009
ASTM F 2601-09	Standard Specification for Fire Safety for Candle Accessories	Prescribes requirements for candle accessories (stability and flammability of candle burners and trim rings)	Originally published in 2007; revised version published in 2009

Table 1: ASTM Candle-Related Standards

discussing possible revisions to these standards (as detailed later in this memorandum) and conducting the required five-year review of each standard.

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ASTM Fire Safety Task Group Activities

One of the task groups under ASTM F15.45 is the Fire Safety Task Group. Since its initial meeting in April 2001, the ASTM Fire Safety Task Group has been meeting regularly to develop fire safety and flammability performance standards for candles and candle accessories. The Fire Safety Task Group has developed two Standards, one for candle fire safety, *Standard Specification for Fire Safety for Candles,* and another for the flammability of candle accessories, *Standard Specification for Fire Safety for Candle Accessories*. Although final versions of the two Standards are published, the Task Group continues to meet regularly to work on new provisions to add to the standards.

Candles: The *Standard Specification for Fire Safety for Candles,* ASTM F 2417, prescribes performance requirements for candles and applies to all candle base materials and candle types. The Standard includes provisions for candle stability,[3] flame height,[4] secondary ignition,[5] and end-of-useful-life behavior.[6]

The test procedure specifies a four-hour burn cycle for all tested paraffin candles and an eight-hour burn cycle for all tested gel and gel-containing candles. The candles' wicks are trimmed in accordance with manufacturers' instructions for testing. The wicks are not trimmed if no instructions are provided.

The most recent version of the Standard, published in 2009, includes an expanded appendix with detailed information and recommendations for manufacturing and testing gel-containing candles. Although gel-containing candles are subject to all the provisions of the Standard, the nonmandatory appendix provides supplementary guidance and safety recommendations for raw materials and finished gel-containing candles.

The 2009 version also includes new provisions for the flammability of tealight cups. The provisions require that all tealight cups, including cups made from plastic materials, be exposed to a flaming ignition source. The tested sample must not exceed a specified total burn time in order to pass the test.

Candle Accessories: A separate Standard for candle accessories, *Standard Specification for Fire Safety for Candle Accessories*, ASTM F 2601, prescribes safety requirements for candle rings, candle holders, candle burners, and potpourri burners. The Standard includes provisions for accessory stability for all candle holders, burners, and holder accessories. The Standard also includes flammability requirements for all components of candle rings, holders, and candle and

[3] Includes freestanding candles, container candles, tealight candles, and candle/accessory ensembles, but not candles needing holders (such as taper candles), votive candles without holders, or certain religious candles.
[4] Includes all candles except candles intended to be burned outdoors.
[5] Includes all candles except certain religious candles.
[6] Includes votive candles, freestanding candles, container candles, and tealight candles, but not taper, birthday, or floating candles.

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potpourri burners. In addition, candle burners and potpourri burners are required to pass additional testing as an ensemble.

The Task Group is considering provisions for other accessory types that are not currently specified in the scope of the Standard. The group is also working on adding definitions to the Standard to clarify the scope.

ASTM Standards Review

ASTM policy requires that approved, published standards be reviewed every five years for accuracy and completeness. Since the last status report, three Standards have been formally reviewed. A formal review of ASTM F 2179—*Standard Specification for Annealed Soda-Lime-Silicate Glass Containers That Are Produced for Use as Candle Containers* was completed, and the Standard was reapproved without changes in 2007. A formal review of ASTM F 2326—*Standard Test method for Collection and Analysis of Visible Emissions from Candles as they Burn* was also completed and the Standard was reapproved without changes in 2009.

A formal review of ASTM F 2058—*Standard Specification for Candle Fire Safety Labeling* began in 2005. Significant changes were made to the Standard during the review process. The revised Standard requires an increased font size to improve readability and is based on the size of the panel in which the warning appears (a minimum font size of 1.3 mm high is required). Abbreviated warnings are allowed for small candles to maximize the available space on smaller labels. Manufacturers have the option of including pictograms in addition to the text warnings on their warning labels. The revised Standard provides guidance on adding nonmandatory messages and safety information to allow flexibility for addressing various needs, such as labels in multiple languages and specific burning instructions. Requirements are also included for the placement and visibility of the label at time of sale. The revised version of the Standard was published in 2007.

A formal review of the *Standard Guide for Terminology Relating to Candles and Associated Accessory Items*, ASTM F 1972-05, began in September 2010.

Industry Involvement

There are several trade associations representing the candle industry. The NCA is the major trade association for the United States candle industry, representing candle manufacturers and their suppliers. Other trade associations representing candle manufacturers include the Consumer Specialty Products Association (CSPA), the International Guild of Candle Artisans (IGCA), and the Association of European Candle Manufacturers (AECM).

The NCA and CSPA assert that their members pledge to comply fully with the ASTM standards for candles. The NCA has approximately 150 members; all members formally pledge to manufacture candles and candle products in accordance with recognized industry standards (e.g., ASTM standards, international industry standards).

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In addition to supporting the development of the ASTM candle standards, the NCA has worked with NASFM to promote candle fire safety. A joint letter and list of guidelines for safely filming and photographing candles were developed and sent to magazines, catalogs, and home décor websites to help avoid inadvertently depicting candles in unsafe settings that may be replicated by consumers. The guidelines address candle placement and safe burning practices. Candle safety information is also available on the NCA's website.[7]

CPSC Staff Participation

CPSC staff has maintained direct involvement in the activities of the ASTM F15.45 Subcommittee and task groups by providing supporting data and actively participating in the development of candle standards. CPSC staff plans to continue participation in upcoming meetings of the Subcommittee and task groups.

Compliance Monitoring and Product Recalls

CPSC staff from the Office of Compliance and Field Operations has conducted several monitoring efforts focusing on conformance to the ASTM candle standards. During fiscal year (FY) 2009, the Office of Compliance requested about 20 technical evaluations of product samples to determine whether the samples were compliant with the ASTM candle standards. Almost all were found to be compliant.

As a result of the staff's technical evaluations and data analysis, there were five recalls in FY 2009 of candles or accessories for fire safety problems, which included about 38,000 candle and accessory products. Of the five candle-related recalls, three involved imported products, and two involved products made in the United States. The three imports came from China. Candles accounted for two of the recalls, and the other three recalls involved candle holders.

One candle recall involved breakage of the glass container. There were ten reported incidents, resulting in two injuries and some minor property damage. This was a heavily fragranced gel candle with a large wooden wick. The second candle recall involved the possibility of flare up, but there were no reported incidents or injuries.

The three recalls of candle holders involved secondary ignition of the holders. There were eight incidents reported overall, including two incidents in which burns to hands were reported, as well as some minor property damage.

In addition to conformance monitoring efforts, CPSC staff also reviewed product complaints. Reports of flashovers and glass breakage accounted for most of the complaints that the CPSC received during FY 2009. Although flashovers accounted for many of the complaints received during FY 2009, complaints about glass breakage had increased significantly from previous years.

[7] www.candles.org.

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Incident Data

CPSC staff produces estimates of fires and fire losses associated with specific consumer products using data from the National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA) Annual Survey of Fire Losses. These estimates are for fire department-attended fires only, and they exclude fires and losses from intentionally set fires and include only civilian casualties.

Based on national fire loss estimates, the three-year average from 2004-2006 of total fire department-attended candle fires was 12,100 fires, resulting in 150 deaths, 1,120 injuries, and $393 million in property loss annually. These estimates include both potentially addressable and nonaddressable candle fires.

Several NFIRS variables are used to determine if a particular incident is a potentially addressable candle fire. Whether a candle fire case is deemed potentially addressable is dependent upon the coding of each of the following variables: *item first ignited*, *factors contributing to ignition*, and *cause of ignition* variables. During the same three-year range, 2004-2006, there was an estimated annual average of 10,300 potentially addressable fire department-attended candle fires, causing an estimated 140 deaths, 890 injuries, and $340 million in property loss. Using the average estimated U.S. population for this period, there were an estimated 0.48 potentially addressable deaths and 3.00 potentially addressable injuries per million people.

In addition to producing fire loss estimates, CPSC staff assigns candle incidents to field investigators to conduct In-Depth Investigations (IDIs). CPSC staff then reviews completed IDIs and characterizes the hazard scenarios. While not statistically representative of all candle fire incidents, the IDIs provide information on the types of candles involved in fire incidents and give insight into candle fire scenarios that have occurred. A detailed discussion of the candle fire estimates and IDIs of candle fire incidents is provided in the memorandum in Appendix I.

Conclusion

This is the second status report on candle standards development activities provided to the Commission since the Commission voted to defer the petition from NASFM to issue mandatory candle standards. CPSC staff will prepare an options briefing package for Commission decision in order to address the petition; however, an analysis of more recent incident data is needed by the staff for preparing an options briefing package.

There is a lag between the data and the development of the candle fire safety standards. The most recent data available is from 2006. While the two standards addressing fire safety were published in 2004 and 2006, both were revised and republished in 2009. Although a schedule for preparing the staff briefing package has not been determined, data from 2009 will likely become available in 2012. Staff typically uses three-year averages when analyzing incident data. In the meantime, CPSC staff plans to continue participation in upcoming ASTM meetings of the Subcommittee and task groups working on developing standards for candles and candle products. Staff will also continue to collect and analyze incident data and monitor industry compliance to the candle standards.

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Appendix I: Memorandum from David Miller, Division of Hazard Analysis, Directorate for Epidemiology, to Allyson Tenney, Directorate for Engineering Sciences, *2004-2006 Candle Fire Loss Estimates*, July 28, 2010.

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Memorandum

October 6, 2010

TO: Allyson Tenney
Directorate for Engineering Sciences

THROUGH: Gregory Rodgers, Ph.D.
Acting Associate Executive Director
Directorate for Epidemiology

Kathleen Stralka
Division Director
Division of Hazard Analysis

FROM: David Miller
Division of Hazard Analysis

SUBJECT: 2004–2006 Candle Fire Loss Estimates[8]

Background

In March 2004, CPSC docketed a petition from the National Association of State Fire Marshals (NASFM) requesting that the voluntary fire safety standards for candles be made mandatory. Additionally, the petition requested that the mandatory Standard incorporate provisions regarding candle accessories and gel candles. In July 2006, the Commission voted to defer a decision on that petition, citing the need to allow time to assess the effectiveness of the voluntary Standards.

This memorandum provides the 2004-2006 estimates of fire department-attended residential structure fires and fire losses where a candle provided the *heat source.*[9] It also provides the 2004-2006 estimates of addressable[10] fires and associated losses where a candle provided the *heat source,* as well as candle fire loss estimates back to 1990, for a broader perspective on candle fires.

Based on data from the National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA) Annual Survey of Fire Losses, CPSC staff produces estimates of fires and fire losses associated with specific consumer products. These estimates are for fire

[8] This analysis was prepared by the CPSC staff and has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.
[9] Heat source is an NFIRS variable for which there is a code (`66 – Candle') for candle.
[10] Addressable is defined as a fire of a type that could be addressed by the candle fire safety standard.

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department-attended fires only. Also, they exclude fires and losses from intentionally set fires and include only civilian casualties.

This memorandum also provides details of CPSC staff's work on in-depth investigations (IDI's) of candle fire incidents. A summary of candle fire IDIs from 2004–2006 is presented.

Estimated Numbers of Fires and Fire Loss

Table 1 provides 2004–2006 annual and three year average estimates for fire department-attended, residential structure, unintentional candle fires and losses. Appendix A details the methodology for these estimates. These fires and losses include both potentially addressable and non-addressable candle fires.

Table 1. Fires and Losses from Fires where a Candle Provided the *Heat Source*[11]

Year	Fires	Deaths	Injuries	Property Loss (in $Millions)
2004	13,400	150	1,240	390
2005	12,100	170	1,070	428
2006	10,800	120	1,040	360
2004–2006 Average	12,100	150	1,120	393

Note: Fires are rounded to the nearest hundred, deaths and injuries to the nearest ten, and property loss to the nearest million dollars.

Fire Losses Addressable by the Voluntary Standard:

Table 2 shows 3-year averages (2004–2006) for estimates of potentially addressable candle fires and associated losses. This data is broken down by different *Items First Ignited*. Appendix A and Appendix B describe the methodology used for producing these NFIRS fire loss estimates.

There was an estimated annual average of 10,300 potentially addressable fire department-attended candle fires in this period, causing an estimated 140 deaths, 890 injuries, and $340 million in property loss. Using 295,605,216[12] as the average estimated U.S. population for this period, there were an estimated 0.48 potentially addressable deaths and 3.00 potentially addressable injuries per million people.

[11] These estimates can be found in Tables 2a-2d in "2004–2006 Residential Fire Loss Estimates," p.9-12, D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.
[12] This is the average of the U.S. Census Bureau population estimates for July 1st of 2004, 2005, and 2006.

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Table 2. Estimated Potentially Addressable Residential Fires and Fire Losses Involving Candles, Attended by the Fire Service, 2004–2006 Annual Average

Item First Ignited	Fires	Deaths	Deaths per million population	Injuries	Injuries per million population	Property Loss in Millions($)
Potentially Addressable Candle Fires	**10,300**	**140**	**0.48**	**890**	**3.00**	**340**
Floor or Wall Covering	900	10	0.05	40	0.12	24
Upholstered Furniture	700	20	0.08	90	0.30	36
Mattress, Bedding	1,200	20	0.07	140	0.49	44
Wearing Apparel, not worn	400	*	0.02	30	0.09	10
Curtains, blinds, drapery, tapestry	1,000	10	0.04	80	0.26	37
Magazines, newspaper, writing paper	400	*	0.01	40	0.15	11
Other Addressable Item First Ignited[13]	5,700	70	0.22	470	1.60	179

Note: Fires are rounded to the nearest hundred, deaths and injuries to the nearest ten, property loss to the nearest million dollars, and death and injury rates to the nearest hundred. Asterisks denote fire deaths estimates of fewer than five. Subtotals do not necessarily add to heading totals due to rounding.

Estimates of candle fires and losses since 1990, that include not just potentially addressable, but also those deemed not addressable, can be seen in Table 3. This table is like Table 1, but it goes back to 1990, and includes per capita estimates.

[13] Some of the common 'Item First Ignited' codes for candle fires that fall into this 'Other' category are ' 00-Other item ignited,' '20–Furniture, utensils, other,' '33–Linen; other than bedding,' '42–Decoration,' and '99–Multiple items first ignited.'

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Table 3. Estimated Residential Fires and Fire Losses Involving Candles, Attended by the Fire Service, 1990–2006

Year	Fires	Deaths	Deaths per million population[14]	Injuries	Injuries per million population	Property Loss in Millions($)
1990[15]	5,400	90	0.36	560	2.24	61
1991	5,900	60	0.24	690	2.74	77
1992	6,000	110	0.43	630	2.47	57
1993	6,400	90	0.35	670	2.60	83
1994	7,100	80	0.31	850	3.27	91
1995	8,400	80	0.30	1,010	3.84	115
1996	10,100	130	0.49	1,200	4.52	169
1997	12,000	160	0.60	1,290	4.82	176
1998	12,800	170	0.63	1,200	4.44	175
1999[16]	15,100	80	0.29	1,480	5.43	272
2000	15,300	130	0.46	1,760	6.24	313
2001	15,900	200	0.70	1,410	4.95	280
2002	14,800	130	0.45	1,300	4.51	363
2003	13,700	200	0.69	1,280	4.42	353
2004	13,400	150	0.52	1,240	4.22	390
2005	12,100	170	0.56	1,070	3.61	428
2006	10,800	120	0.40	1,040	3.50	360

Note: Deaths and injuries are rounded to the nearest ten, property loss to the nearest million dollars, and death and injury rates to the nearest hundred.

[14] Used U.S. Census Bureau Population Estimates for each year.
[15] Data from 1980–1998 obtained from "Revised Residential Fire Loss Estimates 1980–1998," L. Smith, J. Mah, CPSC, July 2002.
[16] Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A.

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Figure 1[*] Estimated Residential Candle Fires, Attended by the Fire Service, 1990 - 2006

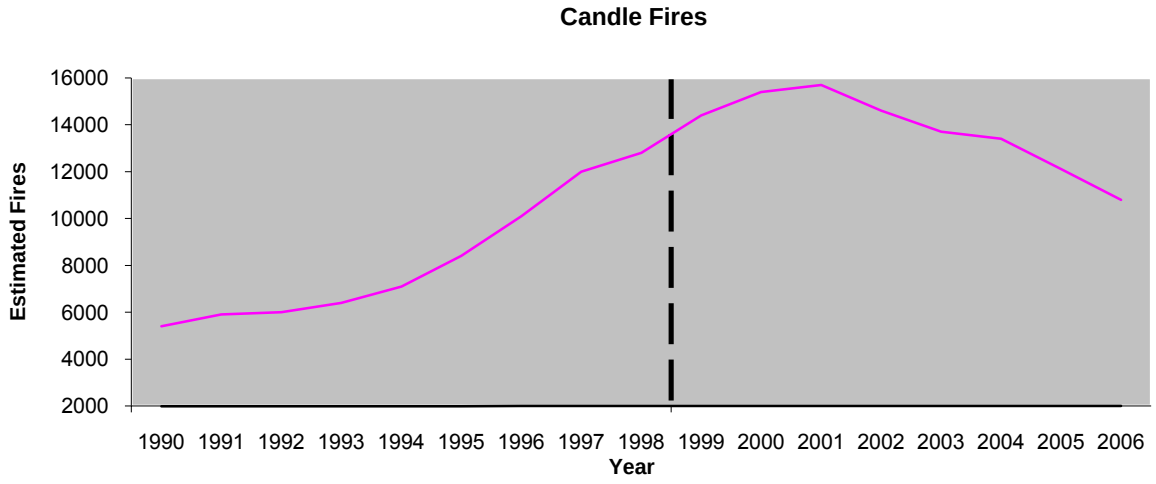
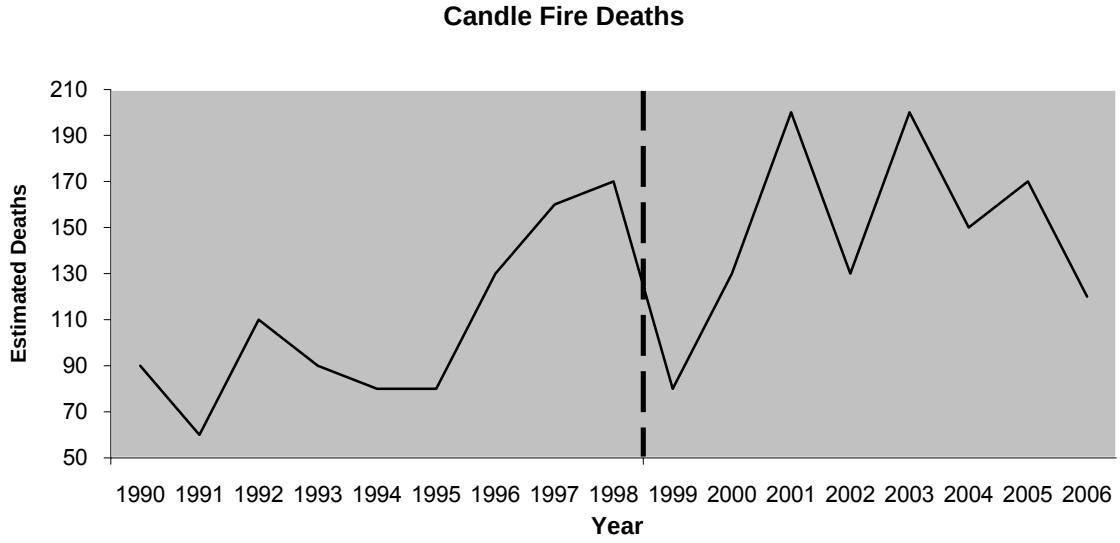


Figure 2[*] Estimated Residential Candle Fire Deaths, Attended by the Fire Service, 1990 - 2006



[*] Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1990–1998 obtained from "Revised Residential Fire Loss Estimates 1980–1998", L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999–2003 Residential Fire Loss Estimates," R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004–2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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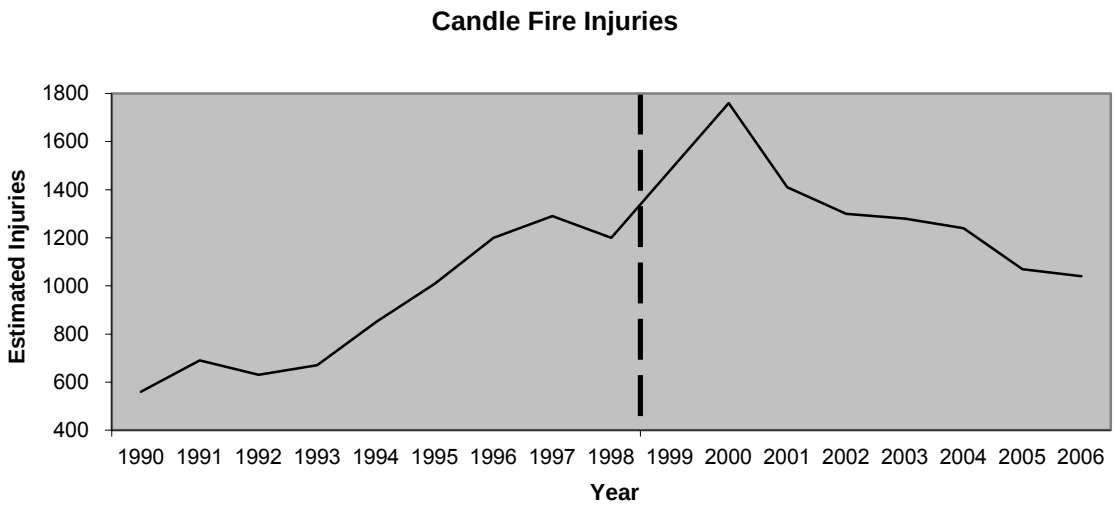
Figure 3* Estimated Residential Candle Fire Injuries, Attended by the Fire Service, 1990 - 2006



Candle Fires and Losses as a Percentage of Total Residential Structure Fires and Losses:

The apparent trends in candle fire and candle fire casualty estimates since 1990 haven't necessarily matched the trends in overall home fires. From 1990–1998, the estimates of fire department-attended residential structure candle fires and candle fire deaths and injuries generally rose as is shown in Figures 1-3. However estimates of total fire department-attended residential structure fires, deaths, and injuries generally declined during this period (See Table 4 and Figures 4-6). Consequently, the estimated proportions of fire department-attended residential structure fires and losses that are candle fires and losses rose dramatically from 1990-1998.

The trend in residential structure candle fires and injuries in the 2000s appears to be generally downward, while the estimates of candle fire deaths show no apparent upward or downward trend (See Table 3 and Figures 1-3). The total residential structure fires and losses show no strong trends (See Table 4 and Figures 4-6). Therefore, the estimated proportion of fire department-attended residential structure fires and injuries that are candle fires and injuries has been decreasing in the 2000s, while the annual proportions of fire deaths that are candle fire deaths appear to bounce around. It can be seen in Figures 7 and 9 that the proportions of fires and injuries attributable to candles clearly rise from 1990 to 1998, and appear to fall in the 2000s (through 2006).

* Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1980–1998 obtained from "Revised Residential Fire Loss Estimates 1980 – 1998," L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999–2003 Residential Fire Loss Estimates", R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004–2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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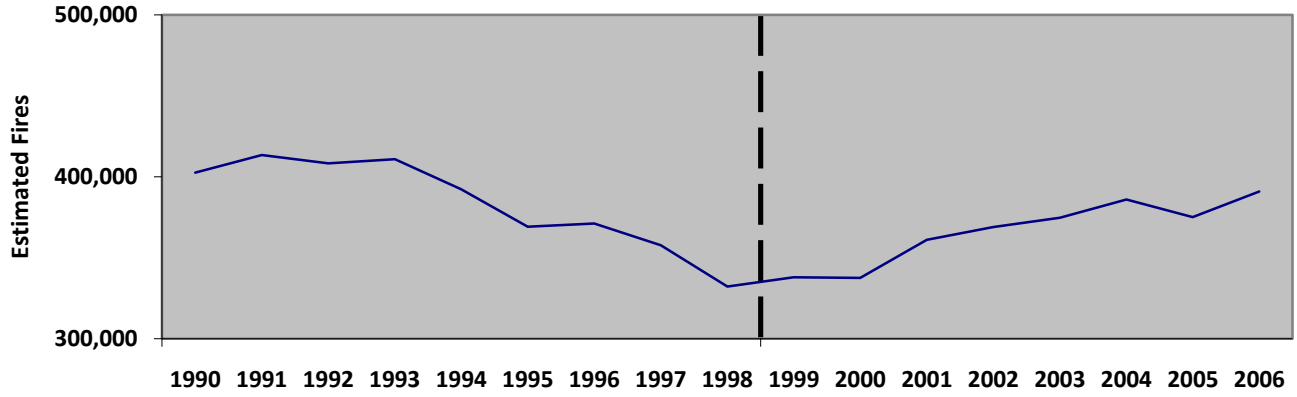
Table 4.* Estimated Residential Fires and Fire Losses Attended by the Fire Service, 1990-2006

Year	Fires	Deaths	Injuries
1990	402,600	3,370	18,180
1991	413,400	2,930	19,170
1992	408,300	3,110	18,980
1993	411,000	3,090	20,190
1994	392,300	2,980	17,540
1995	369,200	3,010	17,010
1996	371,200	3,440	17,030
1997	357,700	2,760	16,080
1998	332,300	2,660	15,260
1999	338,100	2,400	14,590
2000	337,600	2,720	15,740
2001	361,200	2,570	14,040
2002	369,000	2,270	12,870
2003	374,700	2,740	13,120
2004	386,100	2,850	13,330
2005	375,100	2,630	12,820
2006	390,900	2,280	12,070

Figure 4* Estimated Residential Fires Attended by the Fire Service, 1990–2006



* Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1980 – 1998 obtained from "Revised Residential Fire Loss Estimates 1980 – 1998", L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999 – 2003 Residential Fire Loss Estimates", R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004 – 2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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Figure 5* Estimated Residential Fire Deaths Attended by the Fire Service, 1990–2006

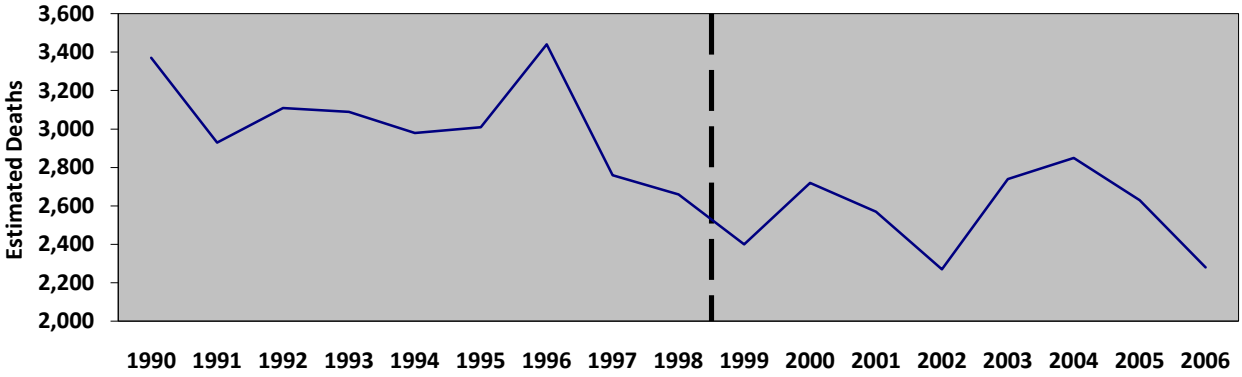
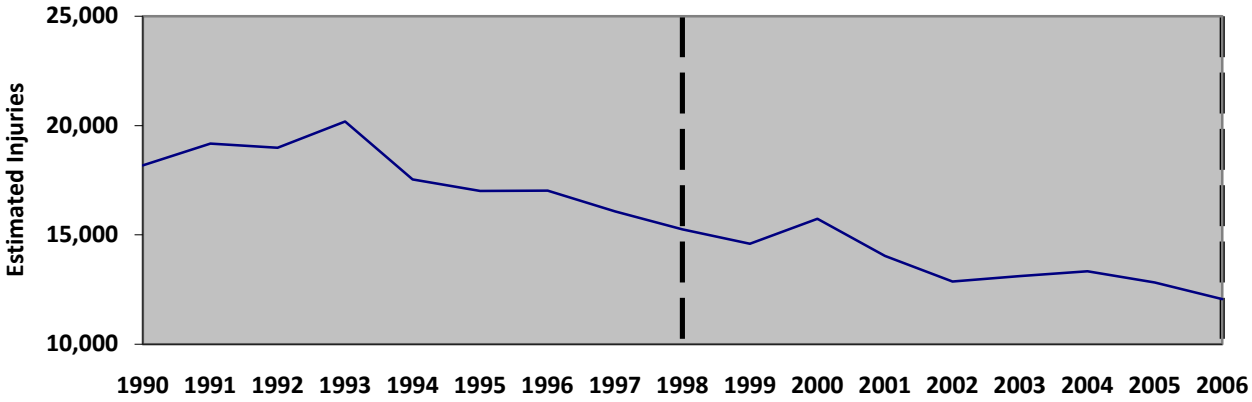


Figure 6* Estimated Residential Fire Injuries Attended by the Fire Service, 1990–2006



* Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999 – 2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1980–1998 obtained from "Revised Residential Fire Loss Estimates 1980–1998", L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999–2003 Residential Fire Loss Estimates," R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004–2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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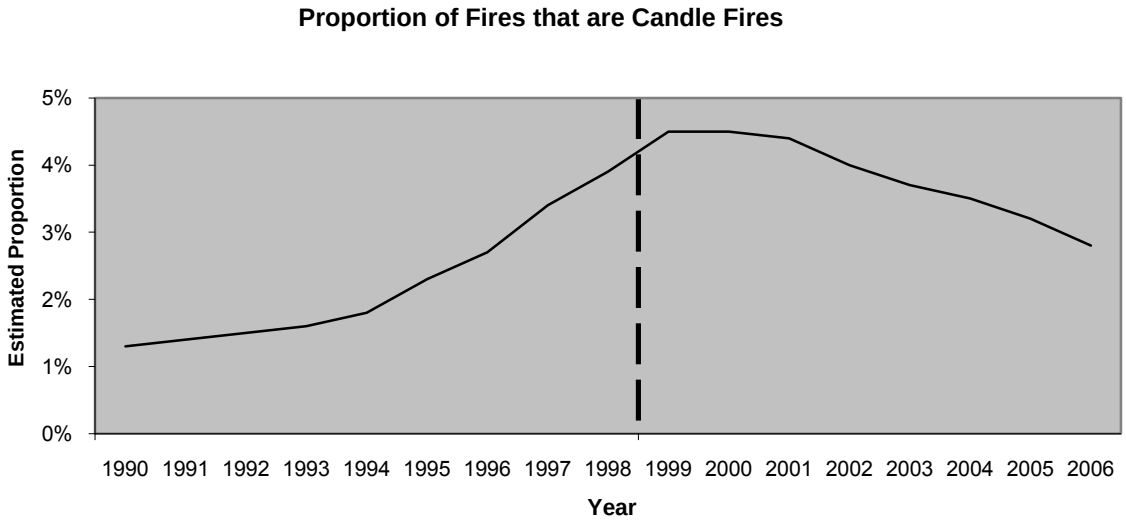
Table 5.* Estimated Proportion of Residential Fires and Fire Losses Attended by the Fire Service where Candle was the Heat Source, 1990-2006

Year	Fires	Deaths	Injuries
1990	1.3%	2.7%	3.1%
1991	1.4%	2.0%	3.6%
1992	1.5%	3.5%	3.3%
1993	1.6%	2.9%	3.3%
1994	1.8%	2.7%	4.8%
1995	2.3%	2.7%	5.9%
1996	2.7%	3.8%	7.0%
1997	3.4%	5.8%	8.0%
1998	3.9%	6.4%	7.9%
1999	4.5%	3.3%	10.1%
2000	4.5%	4.8%	11.2%
2001	4.4%	7.8%	10.0%
2002	4.0%	5.7%	10.1%
2003	3.7%	7.3%	9.8%
2004	3.5%	5.3%	9.3%
2005	3.2%	6.5%	8.3%
2006	2.8%	5.3%	8.6%

Figure 7* Estimated Proportion of Residential Fires Attended by the Fire Service that are Candle Fires, 1990–2006



* Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1980 – 1998 obtained from "Revised Residential Fire Loss Estimates 1980 – 1998", L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999–2003 Residential Fire Loss Estimates", R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004–2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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Figure 8* Estimated Proportion of Residential Fire Deaths Attended by the Fire Service that are Candle Fire Deaths, 1990 – 2006

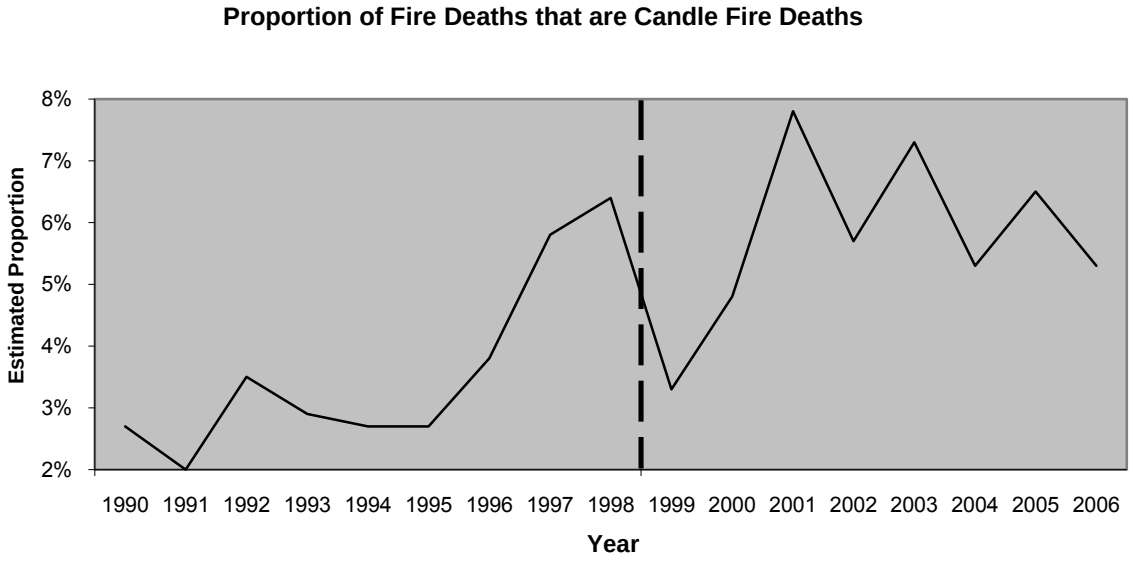
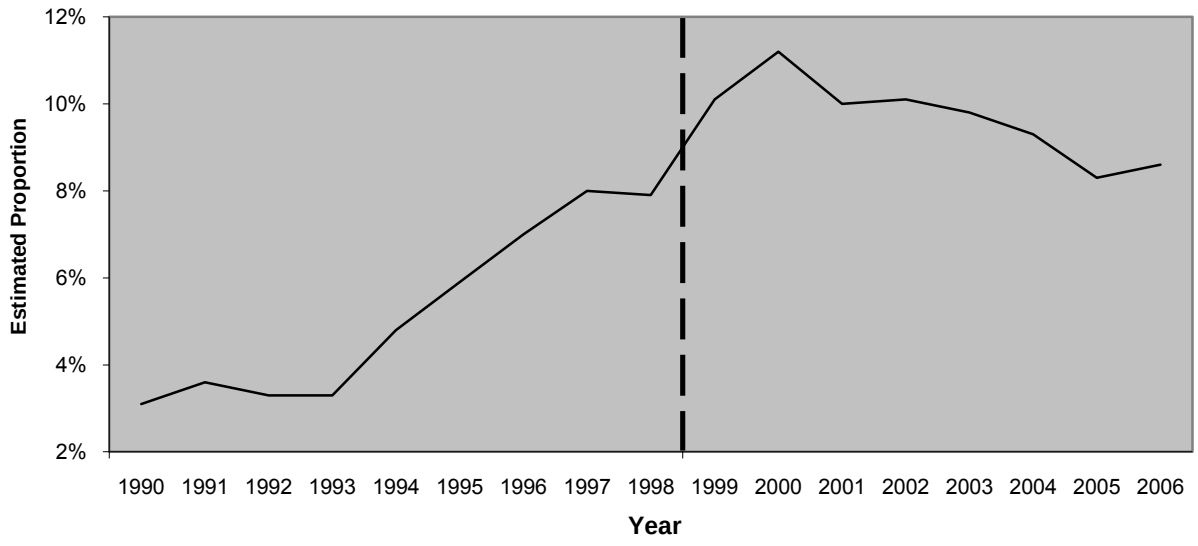


Figure 9* Estimated Proportion of Residential Fire Injuries Attended by the Fire Service that are Candle Fire Injuries, 1990–2006



* Note: 1999 is the first year of the new NFIRS data collection system. Data from Years 1999–2004 are a mix of data coded in version 5.0 and data converted from version 4.1. Data for years prior to 1999 are not directly comparable due to the change in coding systems. Data from 2005 and 2006 are exclusively 5.0 data. A discussion of the different coding systems occurs in Appendix A. Data from 1980–1998 obtained from "Revised Residential Fire Loss Estimates 1980–1998", L. Smith, J. Mah, CPSC, July 2002. Data from 1999–2003 obtained from "1999–2003 Residential Fire Loss Estimates," R. Chowdhury, M. Greene, D. Miller, CPSC, October 2006. Data from 2004–2006 obtained from "2004–2006 Residential Fire Loss Estimates," D. Miller, R. Chowdhury, M. Greene, CPSC, October 2009.

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In-depth Investigations

CPSC staff assigns candle incidents to field investigators to conduct In-depth Investigations (IDIs). CPSC staff reviews completed IDIs and characterizes the hazard scenarios. From January 1998–September 2001, CPSC assigned all candle fire incidents that it became aware of for IDIs. The main source of these incidents was the IPII (Injury and Potential Injury Incidents) database, which is a collection of newspaper accounts, CPSC Hotline reports, internet complaints, reports from medical examiners, and letters to the CPSC. During this 45 month span, 593 IDIs were assigned. Of the assigned incidents, 112 were deemed to be from incidents that are addressable by the voluntary Standard for candles. These comprised the following categories: flare-ups, candle explosions, low wax, container shattering, container ignition, candle reignition, and candle tipping over (not caused by a pet).

In September 2001, the criterion for assigning candle fire incidents for IDIs changed. Cases are still assigned from the IPII batch of cases, but not all are assigned. Cases are assigned for IDI if the IPII comment (a brief description of the incident) gives evidence that the candle exhibited unusual or unexpected behavior, such as flare-ups or tipovers. Now that only a selected set of the cases is assigned, a much higher proportion of the completed candle IDIs are for incidents that are addressable by the candle standard.

The IDIs for 161 incidents occurring between 2004 and 2006 are characterized below since 2006 is the most recent year for which the candle IDIs have been summarized and 2004–2006 are the years for our most recent three-year average fire loss estimates. These cases are not a random sample of all candle fire cases and should not be seen as representative of all candle fire incidents. IPII is not a random sample of fire cases, and the selected set of cases assigned from IPII is not a random sample. The assignments are biased towards incidents where there was somebody who witnessed what happened with the candle. While not statistically representative of all candle fire incidents, the IDIs give insight into some scenarios with a selected set of candle fire incidents where the candle behaved unusually or unexpectedly.

Table 6. 2004 Candle Fire Incident IDIs by Candle Type and Incident Type

Candle Type	Total Incidents	Container/ Holder Broke	Flare -Up	Exploded	Tipo ver	Warmer	Split/ Rupture	Unknown
Filled	12	9	5	3	0	0	0	0
Tealight	15	11	10	2	0	0	0	0
Pillar	17	2	8	3	0	0	9	0
Votive	4	4	2	1	0	0	0	0
Gel	6	2	5	2	0	0	0	0
Taper	3	2	2	0	0	0	0	0
Citronella	0	0	0	0	0	0	0	0
Devotional	0	0	0	0	0	0	0	0
Unknown	4	1	2	1	0	0	0	1
Novelty	1	0	1	0	0	0	0	0
Total	62	31	35	12	0	0	9	1

Note: Some incidents have multiple incident types so detail will not add to total.

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Table 7. 2005 Candle Fire Incident IDIs by Candle Type and Incident Type

Candle Type	Total Incidents	Container/ Holder Broke	Flare -Up	Exploded	Tipo ver	Warmer	Split/ Rupture	Unknown
Filled	28	16	8	5	0	6	1	0
Tealight	13	6	9	0	0	0	0	0
Pillar	9	3	5	0	0	0	2	0
Votive	2	0	2	0	0	0	0	0
Gel	1	0	1	0	0	0	0	0
Taper	4	2	0	0	0	0	2	0
Citronella	5	1	2	2	1	0	0	0
Devotional	2	0	2	0	0	0	0	0
Unknown	2	1	0	0	0	0	1	1
Novelty	2	0	1	0	0	0	0	0
Total	68	29	30	7	1	6	6	1

Note: Some incidents have multiple incident types so detail will not add to total.

Table 8. 2006 Candle Fire Incident IDIs by Candle Type and Incident Type

Candle Type	Total Incidents	Container/ Holder Broke	Flare -Up	Exploded	Tipo ver	Warmer	Split/ Rupture	Unknown
Filled	11	5	4	2	0	3	0	0
Tealight	8	3	4	0	1	0	0	0
Pillar	2	0	1	0	0	1	0	0
Votive	1	1	0	0	0	0	0	0
Gel	5	1	5	2	0	0	0	0
Taper	0	0	0	0	0	0	0	0
Citronella	0	0	0	0	0	0	0	0
Devotional	0	0	0	0	0	0	0	0
Unknown	2	0	0	0	2	0	0	0
Novelty	2	1	0	1	0	0	0	0
Total	31	11	14	5	3	4	0	0

Note: Some incidents have multiple incident types so detail will not add to total.

The tables show the different types of candles and incidents that were seen in the IDIs from 2004–2006 incidents. Filled, tealight, and pillar candles made up a majority of the incidents in each year. Container/holder breakage issues and flare-ups were the most common scenarios seen in each year. There were a total of 15 incidents of a candle splitting or rupturing in 2004 and 2005, but none in 2006. There were 10 candle warmer cases in 2005 and 2006, after none in 2004. While the incidents are not selected as part of a probability sample, and there can be no statistical inference, these IDIs do give an idea of some of the types of candle fire incidents that are occurring.

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Appendix A

Methodology

General:

Estimates of fires and fire losses from fire department-attended candle fires can be derived from the United States Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA) annual survey of fire departments. The NFPA survey is a stratified (by size of community protected by a fire department) random sample of fire departments in the U.S. The NFPA makes national estimates of fire department-attended residential structure fires and associated deaths, injuries, and property loss. They do this by weighting the sample results based on the proportion of the U.S. population accounted for by communities of each size.

NFIRS is a compilation of voluntarily submitted incident reports by U.S. fire departments. The reports have details about product involvement. Not all fire departments submit reports, and it is not a probability sample. NFIRS data are weighted up to the NFPA totals to produce product specific estimates. There are NFIRS estimates for candle fires, deaths, injuries, and property loss, and then appropriate weights are applied to obtain national estimates for candle fires and their associated losses.

NFIRS Coding System Revision:

A new data coding system for NFIRS was introduced in 1999. This is the NFIRS Version 5.0 reporting system. Starting in 1999, fire departments could code their cases in the new 5.0 system, but they also had the choice of coding their cases in the older 4.1 system. Cases coded in 4.1 were converted to 5.0 using computer programs; but conversions are not one-to-one for all variables and codes (there are generally more variables and codes in 5.0). Consequently, there are some differences between the data coded originally in 4.1 and converted to 5.0 and the data coded originally in 5.0. For the years focused on in this report (2004–2006), 89 percent of the 2004 NFIRS data were coded originally in 5.0, 94 percent of the 2005 data, and 95 percent of the 2006 data. For 2005 and 2006, the 4.1 data was excluded, and the weights were produced based solely on the 5.0 data. For 2004, the 4.1 data was left in. Therefore, the 2004 data comprises a mixture of data converted to 5.0 and data originally coded in 5.0. The data for 2005 and 2006 are exclusively 5.0.

Historical Fire Loss Estimates:

The CPSC has been using NFIRS and NFPA to estimate product-specific fires and fire losses for fire department-attended residential structure fires for many years. There are estimates for candles going back to 1980. This report will show estimates back to 1990. These estimates over the years give evidence of an upward trend in the amount of candle fires and associated losses in the 1990s and demonstrate a mostly downward trend since. Since NFIRS is not a probability sample, there are no variance estimates associated with the fire and loss estimates. Therefore, statistical inferences cannot be made on the estimates.

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Addressability:

Several NFIRS variables were used to determine whether a particular incident is a potentially addressable candle fire. Relevant NFIRS variables and codes can be seen in Table B-1 and Table B-2. The variable *heat source* has a code '66–candle' that is used to identify incidents where a candle provided the heat source for the fire. Whether a candle fire case is deemed potentially addressable is dependent upon the coding of each of the following three variables: *item first ignited*, *factors contributing to ignition*, and *cause of ignition*.

There are five *item first ignited* codes that can make a candle fire not addressable. These codes are related to flammable liquid or gas. There are nine *factors contributing to ignition* codes that can make a case not addressable. These range from different codes for 'misuse of product' such as '19 – Playing with Heat Source,' to codes such as '51 – Collision, knock down, run over, turn over' and '66 – Animal.' There is a *cause of ignition* code, '4 – Act of Nature' that makes a case not addressable.

Arson fires are excluded from the estimates as are firefighter casualties. The *cause of ignition* variable is used in conjunction with a created variable called *child play* to identify and eliminate arson cases. Fires coded as 'intentional' are deemed arson unless they are found to be child play. Child play cases are considered not potentially addressable.

The word 'potentially' should be stressed here in the phrase 'potentially addressable.' Determinations of potential addressability of candle fires are being made solely by the coding of a few NFIRS variables. NFIRS does not provide a narrative of the incident. An example of a fairly common scenario that we see in the coding is that a candle is the *heat source* and *the item first ignited* is 'Curtains, blinds, drapery, tapestry.' These cases count as potentially addressable, unless there is some other reason in the coding of another variable or variables (e.g., the *factor contributing to ignition* variable indicates 'playing with heat source' was involved). They are deemed potentially addressable because the candle could have tipped over, or flared up and in this manner, ignited a curtain, for instance. However, the candle may simply have been placed too close to a curtain and led to the fire. This scenario would not be addressable, but there is no way of knowing if this is what happened. Therefore, all such cases are considered 'potentially addressable'.

The codes for the different variables that are used to identify 'potentially addressable' or 'not potentially addressable' candle fires are shown in Table B-2.

Because of the difficulty of determining addressability with NFIRS codes, alternatives were attempted. For injuries, a sample of candle fire In-depth Investigations (IDIs) was examined to see what proportion was addressable by the candle voluntary standard. For deaths, fire reports and death certificates from a sample of candle fires were read to see what proportion was addressable. The idea was to apply these proportions to the NFIRS estimates of total candle fires and injuries to obtain estimates of addressable candle fires and injuries. However, the IDIs, fire reports, and death certificates often did not give enough detail to make a determination of addressability. This was especially true with the deaths, where it could almost never be

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determined. If the start of a candle fire is not witnessed, it is unlikely that it can be learned whether the fire was addressable. At this time, the best option remains relying on the NFIRS data to estimate **potentially** addressable candle fires and losses.

Allocation of Unknowns:

It was possible to have unknown[17] values for each of the NFIRS variables used for this analysis. A technique known as raking was used to allocate the unknown values for each of these variables except for child play. Raking involves an iterative mathematical procedure to adjust a cross-tabulation of the data so that the resulting table, without unknowns, maintains the same proportional relationship as the original cross-tabulation. Battaglia, Hoaglin, and Izrael describe the raking algorithm and provide the statistical software (SAS version 6.12; SAS Institute, Inc., Cary, NC).[18]

Child Play:

In the new NFIRS coding system the coding of child play has become more complicated. In the old system, a case could be coded as child play explicitly using a code from one variable– *ignition factor*. In the new system, there are three variables that must be coded a certain way for a case to count as child play.

In the analysis for another project the inclusion of the child play variable in the raking was found to be problematic and the child play variable was then excluded. It may have been because child play in the new system is defined in a more complicated manner (involving three separate variables). To keep a consistent approach for producing fire loss estimates, child play was excluded from the raking for this analysis. The result is that a case is only considered child play if it is explicitly coded as such. If it has unknown codes for the child play variables, it will **not** count as child play. Before raking, the cause variable was changed to 'unintentional' for child play cases if the cause had been 'intentional' or 'unknown.'

A concern would be underestimating child play by excluding it from the raking and, in so doing, counting some cases as potentially addressable that should not be because they are child play. However, Factor Contributing to Ignition is included in the raking and having Factor Contributing to Ignition = '19 - Playing with Heat Source' is enough for a case to count as not potentially addressable. Therefore, underestimating child play should not cause an overestimate of potentially addressable candle cases.

[17] Some cases have some variables that are not coded so that information is missing. Also, some cases are coded as some form of unknown (e.g., the *cause of ignition* code 'U – Cause undetermined after investigation'). In both instances, the value for a particular variable is unknown and is allocated.

[18] M. Battaglia, D. Hoaglin and D. Izrael, "A SAS Macro for Balancing a Weighted Sample", SAS Users Group International (SUGI) 25th Annual Conference, April 9 -12, 2000, Paper #258-25.

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Appendix B

Table B-1
NFIRS Version 5.0 Codes Used to Identify Candle Fires

Heat Source	**NFIRS Version 5.0 Codes**
Candle	Candle (66)
Not Candle	All codes except for 66, UU, and blank
Item First Ignited	
Floor or Wall Covering	Floor covering or rug/carpet/mat (14) Interior wall covering excluding drapes, etc. (15)
Upholstered Furniture	Upholstered sofa, chair, vehicle seats (21)
Mattress, Bedding	Mattress, pillow (31) Bedding; blanket, sheet, comforter (32)
Wearing Apparel, Not Worn	Wearing apparel not on a person (34)
Curtains, Blinds, Drapery, Tapestry	Curtains, blinds, drapery, tapestry (36)
Magazine, Newspaper, Writing Paper	Magazine, newspaper, writing paper (92)
Other Addressable Item First Ignited	All other codes including: Other item ignited (00) Furniture, utensils, other (20) Decoration (42) And many more
Not Addressable Item First Ignited	Atomized liquid, vaporized liquid, aerosol (61) Flammable liquid/gas – in/from engine or burner (62) Flammable liquid/gas – in/from final container (63) Flammable liquid/gas in container or pipe (64) Flammable liquid/gas – uncontained (65)
Unknown	Undetermined item ignited (UU) Blank ( )

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Table B-2
NFIRS Version 5.0 Codes Used to Identify Addressability for Candle Fires

Variable	Potentially Addressable Candle Fires	Not Potentially Addressable Candle Fires
Item First Ignited	All Other Codes	Atomized liquid, vaporized liquid, aerosol (61) Flammable liquid/gas – in/from engine or burner (62) Flammable liquid/gas – in/from final container (63) Flammable liquid/gas in container or pipe (64) Flammable liquid/gas – uncontained (65)
Factors Contributing to Ignition	No factor contributing to ignition (NN) Abandoned or discarded materials or products (11) Heat source too close to combustibles (12) Improper fueling technique (15) Flammable liquid used to kindle fire (16) Mechanical Failure, Malfunction (20 – 27) Electrical Failure, Malfunction (30 – 37) Installation Deficiency (40 – 44) Accidentally turned on, not turned off (52) Equipment unattended (53) Equipment overloaded (54) Failure to clean (55) Improper startup (56) Equipment used for not intended purpose (57) Equipment not being operated properly (58) Storm (62) High water including floods (63) Earthquake (64) Volcanic action (65) Fire Spread or Control (70 – 75)	Misuse of material or product, other (10) Cutting, welding too close to combustible (13) Flammable liquid or gas spilled (14) Washing part, painting with flammable liquid (17) Improper container or storage (18) Playing with heat source (19) Collision, knock down, run over, turn over (51) High wind (61) Animal (66)
Cause of Ignition	Cause, other (0) Unintentional (2) Failure of equipment or heat source (3)	Intentional (1) Act of Nature (4)

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