



**CIGARETTE LIGHTERS
STATUS REPORT**

October 2006

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Initial pk Date 10/10/06

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ATTACHMENTS

Tab A Memorandum from Charles L. Smith, Directorate for Economic Analysis, to Rohit Khanna, Project Manager, "Lighter Market Information, Estimated Voluntary Standard Conformance and Other Economic Issues Associated with a Potential Mandatory Rule that Addresses Lighter Malfunctions," July 25, 2006.

Tab B Memorandum from Risana Chowdhury, Directorate for Epidemiology, to Rohit Khanna, Project Manager, "Hazards Associated with Cigarette Lighter Malfunctions," July 11, 2006.

Tab C Memorandum from Joe Vogel, Office of Compliance and Field Operations, to Rohit Khanna, Project Manager, "CP 02-1, Petition to Adopt ASTM F400-00 for Cigarette Lighters as Consumer Product Safety Standard under the Consumer Product Safety Act," June 17, 2006.

Tab D Memorandum from Shivani Mehta, Directorate for Engineering Sciences, to Rohit Khanna, Project Manager, "Engineering Analysis of Lighter Conformance Data," July 25, 2006.

Tab E Memorandum from Risana Chowdhury, Directorate for Epidemiology, to Rohit Khanna, Project Manager, "Sample Conformance Rates Based on ASTM F-400 Lighter Test Data," July 24, 2006.

EXECUTIVE SUMMARY

In November 2001, the Lighter Association, Inc. (petitioner) petitioned the U.S. Consumer Product Safety Commission (CPSC) to adopt the voluntary "*Standard Consumer Safety Specification for Lighters*" (ASTM F-400) as a mandatory standard under the Consumer Product Safety Act (CPSA). The requirements of ASTM F-400 address the risk of fire, death, and injury associated with the mechanical malfunction of lighters. The petitioner stated that a mandatory rule was necessary, in its view, to address an unreasonable risk of injury created by the widespread nonconformance of imported lighters to the voluntary standard.

On November 30, 2004 the Commission voted to grant the petition and an advance notice of proposed rulemaking (ANPR) was published in the *Federal Register* on April 11, 2005. This status report describes the work done and the results of the staff effort since that time to estimate the conformance rate of lighters with the ASTM F-400 standard. Updates to the death and injury data and market data included with the staff's petition briefing package are also provided.

The available market data suggest that imported and domestic lighter production totals approximately 1 billion units annually. Imports account for more than 75 percent of the U.S. market. China is the largest lighter-producing country, accounting for 58 percent of lighter imports. Approximately 91 percent of all lighters in the market are disposable and 9 percent are refillable. Members of the Lighter Association represent about 55 percent of the market.

Several data sources were searched for incidents involving malfunctions of lighters. Based on the most recent data available from the National Fire Incident Reporting System (NFIRS) for the period 1999 - 2002, there were an estimated 290 (an annual average of about 70) residential structure fires that may have been caused by malfunctioning lighters. There were no deaths. There were an estimated 50 (annual average of 10) injuries. Property damage associated with these fires was estimated to be \$700,000 (\$175,000 per year) over the four-year period. These estimates are similar to those reported in the petition briefing package for the time period 1994 to 1999.

Based on the most recent years of available National Electronic Injury Surveillance System (NEISS) data, 1997 - 2005, there were an estimated 4,145 emergency department treated injuries (a mean of 461 annually) resulting from malfunctioning lighters; mostly burns to the face, hands, and fingers. Over 94 percent of the injured were treated and released. All medically-attended injuries are estimated using the Commission's Injury Cost Model to average 917 injuries annually. The NEISS data are similar to the data reported in the petition briefing package for the time period 1997 to 2002. From 1997 - 2005, 362 incident

reports related to lighter failures were received; 65 percent of these lighter failures resulted in fires, leading to 4 deaths and some serious injuries. The information in these reports showed that malfunctioning lighters mostly resulted in fire and explosion hazards. The available data do not allow staff to determine if the lighter malfunctions involved in these incidents constitute violations of the ASTM F-400 standard. This updated incident data includes one death in addition to the 3 deaths reported in the earlier package and 6 additional serious injuries (compared to 6 reported earlier).

The CPSC staff conducted a study to estimate the level of conformance of lighters to the voluntary standard. CPSC Field staff collected lighters from various retail establishments in urban, suburban, and rural locations throughout the country. A subset of collected lighters was sent to a contract laboratory for conformance testing. The test results were analyzed by CPSC staff.

Analysis of the test results applied to the lighters collected showed that inexpensive and disposable lighters had conformance rates at or below 40 percent. Among countries, lighters from China had the lowest conformance rate at 30 percent. Lighters from Lighter Association members had a conformance rate of 79 percent and non-members a rate of 30 percent. Based on market information, these results were weighted to project the overall lighter market conformance with the voluntary standard. The staff estimates the current lighter conformance to range from 55 to 58 percent.



United States
CONSUMER PRODUCT SAFETY COMMISSION
 Washington, D.C. 20207

OCT 10 2006

MEMORANDUM

TO: The Commission
 Todd A. Stevenson, Secretary

THROUGH: Page Faulk, General Counsel *PK*
 Patricia Semple, Executive Director *AS*

FROM: Jacqueline Elder, Assistant Executive Director
 Office of Hazard Identification and Reduction

Rohit Khanna, Project Manager *ok*
 Directorate for Engineering Sciences

SUBJECT: Cigarette Lighter Status Report

INTRODUCTION

In November 2001, the U.S Consumer Product Safety Commission (CPSA) received a petition from the Lighter Association, Inc. (petitioner), requesting that the Commission adopt the voluntary "Standard Consumer Safety Specification for Lighters," (ASTM F-400) as a mandatory standard under the Consumer Product Safety Act (CPSA). The petitioner asserted that unreasonable risks of injury are created by imported lighters that do not comply with the voluntary safety standard. On November 30, 2004, the Commission voted to grant the petition. On April 11, 2005, the Commission published an advance notice of proposed rulemaking (ANPR) under the CPSA in the *Federal Register*.

The CPSA staff prepared this status report to provide the Commission with updated information on the current market, relevant incident data, and the level of lighter conformance to the voluntary standard.

LIGHTER MARKET INFORMATION (TAB A)

Product Description

As defined in the CPSA regulations (16 CFR, Part 1210), a cigarette lighter is a flame-producing product commonly used to light cigarettes, cigars, and pipes. The term "lighter" does not include matches or any other lighting device intended primarily to light materials other than smoking materials. Disposable or "non-refillable" lighters account for about 91 percent of the

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total consumption in the U.S. The retail price for disposable lighters generally ranges from \$0.50 to \$1.25.

Market Information

Members of the Lighter Association comprise the major manufacturers and distributors of lighters marketed in the U.S. At the time of the 2001 petition, the Lighter Association stated its members' sales accounted for about 60 percent of total U.S. sales. More recent estimates place the Association's market share at about 55 percent. A member of the Lighter Association reported that at the present time no major Lighter Association members produce lighters in China. Many firms are active in this market as shown by reports filed with the CPSC as required under the Commission's Safety Standard for Cigarette Lighters (child-resistance standard) that addresses the risk of injury caused by child-play fires. As of June 2006, a total of 195 manufacturers and importers intending to market lighters to the U.S. had filed with the CPSC.

The total annual U.S. consumption of lighters is estimated to be about 1 billion units. Imports accounted for more than 75 percent of the lighters sold in the U.S. in 2005. U.S. Census Bureau data on 2005 lighter imports suggest that up to 805 million lighters are imported annually. In 2005, China was the largest import segment of the market, accounting for about 58 percent of lighter imports and 45 percent of overall U.S. lighter consumption. France was the country of origin of about 21 percent of imports and 17 percent of overall consumption. Lighters produced in Thailand, Mexico, and Spain combined for approximately 17 percent of imported lighters and 13 percent of lighter consumption. A substantial portion of refillable lighters from China were inexpensive lighters that would be considered "disposable" lighters under the CPSC child-resistance lighter standard, since the average customs valuation of these lighters was approximately \$0.30. Additional market information can be found in Tab A.

INCIDENT DATA (TAB B)

The risks presented by mechanical malfunctions of lighters typically include fire, laceration, and burn hazards. Several data sources were searched for incidents involving malfunctions of lighters. For the National Fire Incident Reporting System (NFIRS), the estimates from the latest years of available data are presented. Since this data reporting system has undergone major design changes, the new data could not be appended to the previous set of data presented in the 2004 petition package; they are not comparable. However, the difference (in case of cigarette lighter failures) turns out not to be substantial. For the remaining data sources, the data was updated to include the most current years.

The following data sources were searched for incidents involving malfunctions of lighters:

- National Fire Incident Reporting System (NFIRS)
- National Electronic Injury Surveillance System (NEISS)
- Death Certificates file (DTHS)
- Injury or Potential Injury Incident file (IPII)
- In-Depth Investigation file (INDP)

Appendix 1 of Tab B describes the data sources in more detail and the selection criteria used for the searches. The staff analyzed the most recent years of available data for each database. In order to avoid double counting, an incident was counted in the data source that provided the most detail about it.

National Fire Incident Reporting System (NFIRS) 1999 - 2002

U.S. fire departments attended an estimated 290 residential structure fires caused by malfunctioning lighters from 1999 to 2002. These fires resulted in an estimated 50 injuries and a total property loss of \$700,000. The average annual estimates for this period are 70 fires, 10 injuries, 0 deaths, and \$200,000 in property loss.

National Electronic Injury Surveillance System (NEISS) 1997 - 2005

The NEISS database may provide a better estimate of the injuries associated with mechanical failures with lighters than NFIRS estimates because people injured from lighter malfunctions may be more likely to seek hospital treatment than to be attended by fire department personnel. Based on data from NEISS (see Table 1), there were an estimated 4,145 injuries treated in U.S. emergency departments associated with lighter mechanical malfunctions over the nine-year period, 1997-2005, or an average of 461 injuries annually. These estimates should be interpreted with caution due to the small sizes and associated large coefficients of variation.

Table 1 - Annual Estimates of Emergency Room Treated Injuries Resulting from Cigarette Lighter Malfunctions

	ESTIMATED INJURIES	COEFFICIENT OF VARIATION	95% CONFIDENCE INTERVALS
1997	549 (13)	0.315	210 - 888
1998	433 (10)	0.421	76 - 790
1999	587 (12)	0.311	229 - 945
2000	724 (16)	0.304	293 - 1,155
2001	377 (10)	0.368	105 - 649
2002	345 (8)	0.383	86 - 604
2003	178 (7)	0.500	4 - 352
2004	569 (14)	0.329	202 - 936
2005	383 (8)	0.394	87 - 679
TOTAL	4,145 (98)	0.139	3,016 - 5,274
Mean	461 (11)		

Source: NEISS, 1997 - 2005
Sample size shown in parenthesis

There were no reported deaths in the emergency room data. More than 94 percent of the injured were treated and released. The majority (about 83 percent) of the injuries were thermal burns. The face, hands, or fingers accounted for nearly 80 percent of the injured body parts. About 66 percent of those injured were males and 34 percent were females. Approximately 83 percent of those injured were between 15 and 64 years of age.

Death Certificates file (DTHS) 1997 - 2005

The DTHS file contains information from death certificates purchased by CPSC from all 50 states, Washington, D.C., and New York City. For the period January 1, 1997, through December 31, 2005, one death was identified from the DTHS file that may have involved a cigarette lighter malfunction. In this incident, it was reported that a 76-year old female died from 3rd degree burns to over 90 percent of her body when a lighter either ignited her clothing or sprayed fuel on her during the process of lighting her cigarette. Thus, this incident cannot be clearly attributed to a lighter malfunction or noncompliance with the ASTM F-400 standard.

**Injury or Potential Injury Incident file (IPII) & In-Depth Investigation file (INDP)
1997- 2005**

A total of 362 incidents related to lighter malfunctions were identified from January 1, 1997, through December 31, 2005,

from sources including newspaper clippings, consumer complaints, medical examiners' reports, and CPSC in-depth investigations. While not a statistical sample of all incidents that occurred during this time period, these reports provide useful details about the incidents.

A total of 154 individuals were injured in 148 of the 362 incidents. Four individuals died, 12 were hospitalized, 2 were transferred to different facilities; the majority (125) were treated and released. The conditions of the remaining 11 persons were unknown. The lighter exploding on the person was the type of malfunction stated as resulting in the deaths and most of the serious injuries.

Gender was known for 141 of the 154 individuals reported injured (68 were males and 73 were females). Where age was reported, 66 percent of the individuals were in the 15 to 64 age group. One child under the age of 5 was injured; injuries were sustained by 5 individuals in the 5 to 14 year old age group and 9 injuries were sustained by individuals 65 years and older. The distribution of the incidents by hazard type and type of malfunction is shown in Table 2.

**Table 2 - Distribution of the Type of Cigarette
Lighter Malfunction**

TYPE OF MALFUNCTION*	HAZARDS			TOTAL
	Fires	Explosions	Other	
Pressure / volumetric displacement	45	47	10	102
Failure to extinguish	49	0	7	56
Refilling: fuel leakage / gas escape	39	2	11	52
Flame control/height adjustment	42	2	3	47
Sparks / flaring / self-ignition	34	0	5	39
Failure to withstand extreme temperature	8	16	1	25
"Burning time" failure	9	4	2	15
"Drop test" failure	1	11	2	14
Other / unknown	8	0	4	12
TOTAL	235	82	45	362

Source: IPII and INDP, 01/01/97 - 12/31/05

* The type of malfunction classification is based on CPSC staff review of available information; since testing was not conducted, this classification is not definitive.

The failure patterns described in the IPII and INDP files could possibly be addressed by requirements in the ASTM F-400 standard. The most common type of reported malfunction that led to injuries was lighter explosion. The injuries to individuals were caused by the resulting fire or the explosion of the lighter on the person. Incidents allegedly involving lighter explosions led to all of the 4 reported deaths and the majority of the 12 serious injuries requiring hospitalization. The provisions of ASTM F-400 that address lighter explosion hazards include tests that evaluate pressure/volumetric displacement, fuel leakage, and the ability to withstand elevated temperature. Other types of lighter malfunctions that resulted in fires causing injuries are also addressed by ASTM F-400, including failure of the lighter to extinguish its flame, excessive flame height, and the lighter sparking/sputtering/flaring during operation.

Summary of Incident Data

Based on the most recent data available from NFIRS, there were an estimated 290 (an annual average of about 70) residential structure fires for the period 1999 - 2002 that were caused by malfunctioning lighters. No deaths were reported in NFIRS. There were an estimated 50 injuries reported. Property damage associated with these fires was estimated to total \$700,000 for the four-year period.

Based on the most recent years of available NEISS data, 1997 - 2005, an estimated 4,145 injuries (averaging 461 annually) resulted from malfunctioning lighters, mostly burns to the face, hands, and fingers, were treated in hospital emergency departments. Over 94 percent of the injured were treated and released. For the same period, 362 incident reports related to lighter failures were received; 65 percent of these lighter failures were reported as resulting in fires, leading to 4 deaths and 12 serious injuries.

The updated data provided in this report are very similar to what was reported in the May 2004 petition briefing package. The available data do not allow staff to determine if the lighter malfunctions involved in these incidents constitute violations of the ASTM F-400 standard.

RECALL ACTIVITY UPDATE (TAB C)

Since 1973, out of 54 recalls involving lighters, 10 were due to alleged mechanical defects and/or failures that are currently addressed by ASTM F-400. The 10 recalls involved 15.8 million lighters. The recalling firms reported 44 incidents involving these recalled lighters. The recalls have occurred sporadically over the past 33 years. The most recent recall concerning ASTM F-400 related issues was in March 2006. More information on recalls and voluntary standards conformance is provided in Tab C.

LIGHTER CONFORMANCE STUDY (TABS A, D, E)

In support of its petition, the Lighter Association provided test data showing imported lighter models failing to conform to the requirements of ASTM F-400, and recall data from CPSC and Health Canada. In the May 2004 petition briefing package, based on written comments provided by interested stakeholders, the CPSC staff estimated the level of lighter conformance could be 75 percent or more. The CPSC staff noted that a broader study was needed in order to provide a better estimate of lighter conformance.

Lighter Sample Collection

In recent months, the CPSC staff conducted a study to estimate the level of conformance of lighters to the voluntary standard. The CPSC Field staff collected lighters from various retail establishments in urban, suburban, and rural locations throughout the country. Field staff in nine different areas of the country collected 30 units of 13 distinct "inexpensive" lighter models and 10 units of 2 distinct "luxury" lighter models. The sample collection effort focused on "inexpensive" lighters since these lighters dominate the market.

A total of 135 lighter samples were collected. After an analysis of the samples, the staff determined that there were 92 distinct lighter models. Most of the collected samples were "inexpensive" disposable lighters, followed by "inexpensive" refillable lighters. In addition, most of the samples had markings indicating China as the country of origin. No samples were collected of Lighter Association member-produced lighters from China. The lighters collected as a result of the Field effort provided a variety of models across a range of establishments and provided a reasonable sample base of the kinds of lighters readily available to consumers for estimating conformance.

ASTM F-400 Conformance Testing (TAB D)

The number of lighters collected exceeded the number of samples allocated for testing. In order to account for as many lighter models, types, and countries of origin as possible, the staff applied a decision process in the selection of the 50 lighter models sent for conformance testing. This decision process is detailed in Tab D. The 50 lighters selected were sent to a contract test laboratory for testing in accordance with the performance requirements of ASTM F-400. The labeling requirements of ASTM F-400 were not evaluated.

The requirements of ASTM F-400 address the risks of fire, death, and injury associated with mechanical malfunction or failure of the structural integrity of a lighter through a series of performance tests. The applicable performance tests depend on properties of the lighter such as its fuel type (liquid or gas), presence of flame height adjustment, or if it is refillable. The ASTM F-400 standard does not provide guidance on allowable lighter failure rates for performance tests. It is reasonable to assume that some failures of lighters can occur due to manufacturing quality issues associated with a particular lighter model. Due to the small sample sizes that could be reasonably collected from retail establishments, a lighter failing any applicable provision was reported as a failure to conform for that particular model.

Analysis of Test Results

Of the 50 lighter models tested, 28 models had units failing one or more applicable test provisions. The ASTM F-400 test provision associated with the most failures was Section 4.6 *Volumetric Displacement*. This requirement evaluates if the lighter's fuel chamber is overfilled and can lead to a potential explosion hazard. The test provision associated with the second most common failure was Section 4.4 *Spitting or Sputtering and Flaring*. Spitting and sputtering occurs when unburned liquid separates from the lighter's main flame and results in the eruption of smaller flames. These flames can present burn

hazards or ignite nearby combustibles causing a fire. After the staff analyzed the test results, additional analyses were conducted to estimate the level of conformance of all the samples collected and the overall U.S. market.

Collected Lighter Sample Conformance Rates (TAB E)

Lighter test results were used to make conformance rate estimates for the lighters collected. The overall conformance rate of collected lighters was 45 percent. For the various lighter categories, the inexpensive/disposable/adjustable and inexpensive/disposable/refillable lighters had conformance rates at or below 40 percent. Among countries, lighters from China had the lowest conformance rate at 30 percent. Lighters made by Lighter Association members had an overall conformance rate of 79 percent and non-members had a conformance rate of 30 percent.

Overall Lighter Market Conformance Estimate (TAB A)

The staff further adjusted the conformance rates for the lighter samples collected to estimate the overall conformance of lighters in the U.S. market. Weighted conformance based on information on country of origin resulted in estimated market conformance of 55 percent to 58 percent for lighters marketed in the U.S. in 2005. The staff also weighted conformance testing results by market information on membership in the Lighter Association. This resulted in estimated overall market conformance of about 57 percent for 2005, which is within the estimated range of conformance based on market data on country of origin.

SOCIETAL COSTS AND POTENTIAL COMPLIANCE COSTS ASSOCIATED WITH MALFUNCTIONING LIGHTERS (TAB A)

Societal Costs

According to estimates made using the CPSC's Injury Cost Model, there may be about 917 medically attended injuries annually that involve lighter malfunctions (this includes injuries treated in hospital emergency departments reported through NEISS and injuries treated in other medical facilities), although available data do not allow for a definitive determination that the malfunctions constitute violations of the ASTM F-400 standard. The societal costs associated with these injuries and any property damage may amount to \$31 million annually.

Potential Benefits

A mandatory rule based on ASTM F-400 could have an average potential benefit of \$0.03 per lighter (\$31 million / 1 billion lighters). These potential benefits would depend on the effectiveness of the standard in reducing the occurrence of

malfunctions and the current level of conformance to the voluntary standard.

For the approximately 1 billion lighters purchased by consumers annually, the estimated risk of injury associated with lighter malfunctions potentially involving nonconformance with the ASTM F-400 standard is about 0.9 per million lighters (917 injuries/1 billion lighters). This is about 12 percent of the overall risk of medically-attended injury associated with lighters from all causes (including misuse, carelessness, and child play), which is estimated to be 7.6 per million lighters.

Potential Costs of Compliance with a Mandatory Rule

Costs for lighters currently manufactured in conformance with ASTM F-400, and subjected to testing for assurance to conformance, should not increase under a mandatory standard. Manufacturing costs would be expected to increase for firms that do not currently conform to ASTM F-400. Per-unit cost increases would depend on the nature and numbers of standard provisions that are not met by current production, and the labor, material, and equipment costs required to meet those provisions. The Commission has received comments characterizing likely compliance costs as being "minimal" and "a matter of a penny or two per lighter." Given the availability of imported disposable lighters with reported customs values of just a few cents, these characterizations of the likely costs may be reasonable.

TAB A



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: August 15, 2006

TO : Rohit Khanna, Project Manager, Lighters

THROUGH : Gregory B. Rodgers, Ph.D., AED, Directorate for Economic Analysis *GBR*
Deborah V. Aiken, Ph.D., Senior Staff Coordinator, Directorate for
Economic Analysis *DVA*

FROM : Charles L. Smith, Directorate for Economic Analysis *CLS*

SUBJECT : Lighter Market Information, Estimated Voluntary Standard Conformance
and Other Economic Issues Associated with a Potential Mandatory Rule
that Addresses Lighter Malfunctions

Introduction

In November 2004, the U.S. Consumer Product Safety Commission (CPSC) voted to initiate rulemaking for the development of a safety standard to address the hazards of malfunctioning cigarette lighters.¹ One regulatory alternative is a mandatory rule based on provisions of an existing voluntary standard, ASTM F-400 (*Standard Consumer Safety Specification for Lighters*). That standard includes requirements that address many of the hazard scenarios observed in hazard data (e.g., those relating to maximum flame height, proper flame extinction, maintaining structural integrity when the lighter is exposed to hot or cold temperatures, maintaining structural integrity after a "drop" test, and requirements for internal pressure and fuel levels). In support of this rulemaking, CPSC staff evaluated the U.S. market conformance to ASTM F-400 by subjecting a sample of lighters to tests specified by the standard. The lighters in the sample had a variety of characteristics and prices and were acquired at retail from several different types of retail establishments from around the nation. This memorandum presents information on the testing results and estimates of market conformance to the voluntary standard. Estimated hazard costs associated with lighter malfunctions and likely compliance costs of a mandatory standard based on ASTM F-400 are also discussed.

Given the sample of lighters collected for the testing program, the Directorate for Epidemiology found that about 45 percent of lighters conformed to ASTM F-400.² The purpose of the analysis presented in this memorandum is to adjust this sample-based conformance rate by

¹ Possible requirements of a standard would be in addition to the child-resistance requirements for lighters in the CPSC standard that has been in effect since 1994.

² Chowdury, Risana, Division of Hazard Analysis, Directorate for Epidemiology. Memorandum to Rohit Khanna, Project Manager, Cigarette Lighter Project, "Conformance Rates Based on ASTM F-400 Lighter Test Data," July 2006.

considering market share data on country of origin and membership in the Lighter Association to estimate the proportion of lighters sold in the U.S. that conforms to ASTM F-400. Although consideration of market share data resulted in a range of estimated market conformance that was somewhat higher than shown by the sample tests, overall estimated conformance was less than 60 percent.

Lighter Market Information

The rulemaking under consideration originated with a petition filed with the CPSC by the Lighter Association, which requested that the voluntary standard for lighters, ASTM F-400, be adopted by the CPSC as a mandatory rule. The Lighter Association is comprised of most major manufacturers of lighters marketed in the U.S., including BIC, Calico, Colibri, Djeep, Scripto-Tokai, Swedish Match (Cricket), Ronson, and Zippo. Although association members reportedly account for a slight majority of lighters sold in the U.S., their share of the market has fallen in recent years. Many other firms are also active in this market as shown by reports filed with the CPSC that are required under the Commission's Safety Standard for Cigarette Lighters (which mandated requirements for child-resistance). As of June 21, 2006, a total of 195 manufacturers and importers intending to market lighters in the U.S. had filed with the Commission.

As shown in Table 1, U.S. Census Bureau data on 2005 imports of non-refillable³ and refillable pocket lighters suggest that up to 805 million lighters imported annually could be subject to a lighter standard based on the provisions of ASTM F-400. Imports accounted for more than 75 percent of total estimated U.S. consumption of pocket lighters in 2005. China dominates the import segment of the market, accounting for 58 percent of pocket lighter imports and about 45 percent of all lighter consumption in 2005.⁴ France was the country of origin for about 21 percent of imports and 17 percent of total consumption. Thailand, Mexico, and Spain combined for about 17 percent of imported lighters and about 13 percent of total consumption. About 90 percent of all imported lighters in 2005 were non-refillable. The only significant country of origin for refillable lighters was China. A substantial proportion of refillable lighters from China were inexpensive lighters that could be considered to be disposable, since they had an average customs value of only \$.30. Domestic lighter production could bring total annual U.S. consumption to more than 1 billion units.

At the time that its petition was filed in 2001, the Lighter Association stated that its members accounted for at least 60 percent of the total lighter market in the U.S. More recent estimates place the association's market share at about 55 percent of "disposable lighters," (*i.e.*, non-refillable lighters and inexpensive refillable lighters).⁵

³ Non-refillable lighters are referred to as "disposable lighters" in memoranda from the Directorates for Engineering Sciences and Epidemiology.

⁴ Imports from China and Hong Kong are reported separately by the U.S. Department of Commerce, but are combined in this analysis.

⁵ Based on U.S. Lighter Market Information presented to the CPSC staff at an October 2005 meeting by Ross Knapp, Calico Brands, Inc. (Lighter Association member firm).

Estimated Voluntary Conformance

CPSC Field staff collected 135 lighter samples from retail establishments around the country. With duplicates of 23 models, 92 distinct models were collected for evaluation. Funding was available to subject 50 models to testing to ascertain conformance to ASTM F-400, with emphasis on testing provisions that address fire and explosion hazards. The Directorate for Engineering Sciences (ES) considered a sample to have failed the testing program if one unit in the sample failed one or more tests. On this basis, ES found that about half of the samples tested did not achieve passing results. Details of the testing program are provided in a memorandum from ES.⁶

Non-refillable lighters account for about 91 percent of total estimated lighter consumption in the U.S. Tests performed on non-refillable lighters found conforming results for about 15 percent of the lighter samples from China; 100 percent of samples from France; 50 percent of samples from Thailand, Mexico and Spain; and 100 percent of samples from other nations (as shown in Table 2). Multiplying country sample conformance rates by estimated market shares provides an estimated weighted conformance rate for non-refillable lighters. By adding the estimated weighted conformance rates for lighters from other nations to that of U.S. production (100 percent of which were found to have conforming results), the overall conformance for non-refillable lighters marketed in the U.S. is estimated to range from 57 percent to 59 percent.

Similar calculations have been made for refillable lighters, which account for about 9 percent of total U.S. lighter consumption. If the lower conformance rate of 30 percent for disposable refillable Chinese lighters is assumed to represent the performance of all refillable lighters originating in China, the overall conformance for refillable lighters is estimated to be about 41 percent (when combined with the 100 percent conformance rate of refillable lighters made in the U.S.). If the testing results of more expensive refillable Chinese lighters are combined with those of the less expensive lighters, the estimated conformance rate for refillable Chinese lighters increases to 44 percent, and the overall conformance rate for refillable lighters (including U.S. production) increases to about 50 percent. (See Table 2.)

Based on information on imports of lighters and market information on U.S. lighter production, a weighted rate of conformance with ASTM F-400 for all pocket lighters marketed in the U.S. in 2005 is estimated to be 55 percent to 58 percent.

Conformance may also be estimated by weighting test results according to estimated market shares held by firms that are members of the Lighter Association and those that are not members. Based on market information provided to the CPSC staff in 2005, Lighter Association members held a combined market share of about 55 percent of "disposable" lighters. Production of more expensive refillable lighters by member companies could result in a minor increase in the overall share of lighter consumption held by the Lighter Association firms. Bic is reportedly the largest producer of disposable lighters for the U.S. market among association members,

⁶ Mehta, Shivani, Division of Combustion and Fire Sciences, Directorate for Engineering Sciences, Memorandum to Rohit Khanna, Project Manager, Cigarette Lighter Project, "Engineering Analysis of Lighter Conformance Test Data," July 2006.

followed by Calico, Scripto, Cricket, Ronson, and Djeep.⁷ Weighting the results of testing by reported market shares held by individual Lighter Association member firms yields an estimated conformance rate of about 84 percent for lighters produced by members of the Lighter Association. About 24 percent of the lighter samples from manufacturers that are not members of the Lighter Association were found to be in conformance with ASTM F-400. Weighting the estimated conformance rates by market shares held by firms that are members of the Lighter Association and those that are not yields overall estimated conformance with ASTM F-400 of about 57 percent. This is within the estimated range of conformance based on market data on country of origin.

As noted above, these estimated conformance rates are based on all lighters in a sample passing all of the applicable tests. The number of lighter units in samples ranged from 10 to 32 units, with most samples containing 30 lighters. Some tests were only performed on one unit in each sample. As the Directorate for Engineering Sciences notes in its memorandum discussing the testing results, of 28 samples with failures, 13 failed only one of the test provisions. Further, samples of up to 30 units were considered to be nonconforming even though nearly all units in the sample passed their tests. A larger sample that subjects more units of a sample to tests to derive an average rate of conformance for each provision of ASTM F-400 could have resulted in a higher overall estimate of market conformance than the estimate of 55 percent to 58 percent based on all passing results for all units in samples.

Societal Costs Associated with Malfunctioning Lighters

The Directorate for Epidemiology's Division of Hazard Analysis presented hazard data involving likely cigarette *lighter malfunctions*.⁸ NFIRS and NFPA data show an average of about 70 fires, 10 injuries, and \$200,000 in property losses annually from cigarette lighter malfunctions from 1999 through 2002. No deaths from lighter malfunctions were reported through NFIRS during this period.

NEISS data involving cigarette lighter malfunctions show that there were an estimated 4,145 injuries treated in hospital emergency rooms from 1997 through 2005, a mean of 461 injuries annually over that period. Over 94 percent of these estimated injuries were treated and released, according to the Division of Hazard Analysis. There were no deaths reported from the emergency room data. According to estimates made with the Commission's Injury Cost Model, other medically-treated injuries (other than those treated in hospital emergency rooms) bring the total annual number of injuries involving lighter malfunctions to about 917 per year during the 1997–2005 time period. The Directorate for Economic Analysis estimates that the value of

⁷ Bic is the only Lighter Association member that produces disposable lighters in the U.S. Bic samples made in France and Spain were also purchased at retail in the CPSC conformance study. Other disposable lighters made by Lighter Association members purchased for the conformance study included Calico lighters made in Thailand, Scripto lighters made in Mexico, Cricket lighters made in the Philippines, and Djeep lighters made in France. If non-disposable lighters made in the U.S. by association member, Zippo, are also considered, we estimate that 55% to 62% of lighters made by Lighter Association members in 2005 were imported.

⁸ Chowdhury, Risana, Division of Hazard Analysis, Directorate for Epidemiology, CPSC. Memorandum to Rohit Khanna, CPSC Project Manager for the Lighter Petition, "Hazards Associated with Cigarette Lighter Malfunctions-Update," July 23, 2006.

annual hazard costs from injuries and property losses that might be related to lighter malfunctions could total about \$31 million.⁹

Since the average useful life of a lighter may be less than two months, it is appropriate to compare risks and societal costs in a year to lighters purchased in a year, rather than to estimated numbers of lighters in use at a given time. For the approximately 1 billion lighters purchased by consumers in a year, the estimated risk of injury due to lighter malfunctions is about 0.9 per million lighters (917 injuries / 1 billion lighters). This accounts for about 12 percent of the overall risk of medically-attended injury associated with lighters, which is estimated to be about 7.6 per million lighters.¹⁰

The average societal costs (associated with injuries and property losses) from incidents involving lighter malfunction are about \$.03 per lighter (\$31 million / 1 billion lighters).¹¹ If lighters that do not meet the requirements of the voluntary standard present greater safety risks, and are disproportionately involved in incidents resulting in injuries and property loss, the expected societal costs of nonconforming lighters would be greater than \$.03. It is important to note that the CPSC staff does not know the percentage of incidents that involve nonconforming lighters, or even whether nonconforming lighters are over-represented in the lighter malfunction incidents. Further, although testing provisions of ASTM F-400 could address lighter malfunctions that have been observed in incidents (e.g., through provisions related to volumetric displacement and flame control and adjustment), the staff does not know the extent to which lighter malfunction incidents would be reduced by conformance. Thus, we do not know the extent of the benefits that might be achieved by a mandatory standard based on the provisions of ASTM F-400.

Potential Costs of Compliance with a Mandatory Rule based on ASTM F-400

In comments submitted in response to the advance notice of proposed rulemaking that was published in the April 11, 2005, *Federal Register*, Felix Hon, President of Calico Brands, Inc., stated that “The cost of compliance [with the voluntary standard] is minimal and would not work any undue hardship on the industry or consumers.” According to previous comments submitted to the Commission by the Lighter Association, the “cost of complying with ASTM F 400-00 is a matter of a penny or two a lighter, at most...”¹² This assessment appears to be reasonable given the low total per unit manufacturing costs for lighters (the average Customs Value of non-refillable lighters imported from China in 2005 was only about \$.05). Further, 12

⁹ Estimated hazard costs are based on average injury costs of about \$33,745 (2004 dollars) assigned to injuries estimated from NEISS data, including those treated in emergency departments and other medically-attended injuries (with an estimated average annual total of \$30.9 million); and estimated average annual property losses (from NFIRS data) of \$200,000.

¹⁰ Based on estimates provided by the CPSC’s Injury Cost Model, the annual number of medically-treated injuries involving lighters averaged 7,693 for the period 1997–2005.

¹¹ As noted above, the societal cost estimates are based on hazard data averaged over time. If, however, lighters currently purchased by consumers are less likely to malfunction than lighters in use during the period covered by the hazard data, potential benefits would be smaller. For example, this could be the case if more lighters conform to the voluntary standards because of the Chinese inspection program adopted in 2001.

¹² Smith, Charles L., Directorate for Economic Analysis, Memorandum to Rohit Khanna, Project Manager for the Lighter Petition, “Lighter Petition (Petition CP 02-1): Economic Considerations,” March 10, 2004.

of the 28 samples that had failing test results in conformance testing involved failures of just one provision, with failures being observed in a minority of lighters in the samples.¹³ This could indicate that compliance could be achieved through tighter control over manufacturing processes without the need for product modifications.

Summary

Based on market information on lighters, weighted estimates of conformance with ASTM F-400 for lighters sold in the U.S. in 2005 range from 55 percent to 58 percent. Although estimated annual societal costs associated with lighter malfunctions total \$31 million, benefits that might be achieved by a mandatory standard based on the provisions of ASTM F-400 are uncertain.

¹³ Mehta. *op.cit* p.7.

Table 1. 2005 Estimated Imports and U.S. Production of Lighters for Domestic Consumption

	Non-refillable Lighter Imports and Domestic Production		Refillable Lighter Imports and Domestic Production		Total Imports and Domestic Production of Lighters		
	Quantity	% of Total Non-refillable*	Quantity	% of Total Refillable*	Quantity	Percent of Total Imports	Percent of Total Lighter Consumption*
China & Hong Kong	392,535,505	40.2% to 42.3%	77,897,222	83.6% to 88.4%	470,432,727	58.4%	44.0% to 46.3%
France	172,096,405	17.6% to 18.6%	23,109	0.0% to 0.0%	172,119,514	21.4%	16.1% to 17.0%
Thailand	74,431,800	7.6% to 8.0%	0	0.0% to 0.0%	74,431,800	9.2%	7.0% to 7.3%
Mexico	42,054,676	4.3% to 4.5%	0	0.0% to 0.0%	42,054,676	5.2%	3.9% to 4.1%
Spain	21,766,828	2.2% to 2.3%	20,000	0.0% to 0.0%	21,786,828	2.7%	2.0% to 2.1%
Other Nations	24,220,552	2.5% to 2.6%	182,524	0.2% to 0.2%	24,403,076	3.0%	2.3% to 2.4%
Total Imports	727,105,766	74.4% to 78.4%	78,122,855	83.9% to 88.7%	805,228,621	100.0%	75.2% to 79.3%
U.S. Production	200,000,000 to 250,000,000	21.6% to 25.6%	10,000,000 to 15,000,000	11.3% to 16.1%	210,000,000 to 265,000,000	n/a	20.7% to 24.8%
Total U.S. Consumption	927,105,766 to 977,105,766	about 91% of total consumption	88,122,855 to 93,122,855	about 9% of total consumption	1,015,228,621 to 1,070,228,621		

* The range for imports is due to the range of 1.015 billion to 1.070 billion lighters consumed in the U.S. annually.

Table 2. Estimated Conformance with ASTM F-400 Based on Country of Origin and Market Information

	Non-refillable Lighters				Refillable Lighters			
	% of Total Non-refillable	Estimated Conformance Rate	Weighted Conformance Rate		% of Total Refillable	Estimated Conformance Rate	Weighted Conformance Rate	
China & Hong Kong	40.2% to 42.3%	15%	6% to 7%		83.6% to 88.4%	30%* to 44%**	25% to 39%	
France	17.6% to 18.6%	100%	18% to 19%		0.0% to 0.0%	n/a	n/a	
Thailand	7.6% to 8.0%	50%	4% to 4%		0.0% to 0.0%	n/a	n/a	
Mexico	4.3% to 4.5%	50%	2% to 2%		0.0% to 0.0%	n/a	n/a	
Spain	2.2% to 2.3%	50%	1% to 1%		0.0% to 0.0%	n/a	n/a	
Other	2.5% to 2.6%	100%	2% to 3%		0.2% to 0.2%	n/a	n/a	
Total Imports	74.4% to 78.4%	--	33% to 35%		83.9% to 88.7%	--	25% to 39%	
U.S. Production	21.6% to 25.6%	100%	22% to 26%		11.3% to 16.1%	100%	11% to 16%	
Overall Conformance Rate by Lighter Type			57% to 59%				41% to 50%	

* Conformance rate for Chinese refillable lighters based on the performance of disposable lighters only.

** Conformance rate for Chinese refillable lighters if testing results of more expensive lighters are combined with those of disposable lighters.

Note: The range for imports is due to the range of 1.015 billion to 1.070 billion lighters consumed in the U.S. annually

TAB B



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: July 11, 2006

TO : Rohit Khanna, Project Manager
Directorate for Engineering Sciences

THROUGH: Russell H. Roegner, Ph.D. *RR*
Associate Executive Director
Directorate for Epidemiology

Kathleen Stralka *KS*
Director
Division of Hazard Analysis

FROM : Risana Chowdhury *R.C.*
Division of Hazard Analysis

SUBJECT : Hazards Associated with Cigarette Lighter Malfunctions*

The Lighter Association, Inc. filed a petition requesting that the Standard Consumer Safety Specification for Lighters (ASTM F-400) be adopted as a mandatory consumer product safety standard. This stemmed from the Association's concern about the presence of lighters in the market that fail to meet the safety requirements in this standard. The Commission granted the petition and in April 2005, published an advanced notice of proposed rulemaking. This memorandum summarizes the hazard data associated with cigarette lighter malfunctions.

Methodology

The focus of this data search was on mechanical failures of cigarette lighters, reported during the most recent years of available data. Five databases were searched for identification of these incidents: the National Fire Incident Reporting System (NFIRS), the National Electronic Injury Surveillance System (NEISS), the Death Certificates file (DTHS), the Injury or Potential Injury Incident file (IPII), and the In-Depth Investigation file (INDP). Appendix 1 details information about these data sources and the selection criteria used for this data search.

The risks posed by malfunctions of cigarette lighters primarily include fire, laceration, and burn hazards. In their petition, the Lighter Association described eight common types of mechanical failures in lighters that were of concern. As defined by the ASTM F-400 standard, these were:

- Flame control or height adjustment problem
- Sparks or flaring
- Pressure or volumetric displacement concerns

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

- Failure to extinguish
- “Drop test” failure, which means dropping a lighter onto a hard surface results in an explosion, self-ignition, gas escaping, or the lighter’s subsequent safe operation is impaired
- “Burning-time” failure, which means the lighter is incapable of withstanding a burning time of 5 seconds without burning or distorting components leading to a hazardous condition
- Refilling problem: fuel leakage or gas escapes
- Failure to withstand elevated temperature of 65°C (149°F) for 4 hours under test conditions.

In general, only the data from IPII and INDP provided sufficient detail on the type of hazard and the type of malfunction involved (as described above) in each incident.

Results

Estimated Residential Structure Fire Losses Attended by the Fire Service: An estimated 290 non-incendiary and non-suspicious residential structure fires caused by faulty cigarette lighters were attended by fire departments nationwide between 1999 and 2002. While there were no deaths, there were an estimated 50 injuries associated with these fires and the total estimated property loss was \$0.7 million dollars. Table 1 provides the yearly details. Effective from 1999, the NFIRS data coding system underwent a major revision. As such, estimates for 1999 and later years are not comparable to estimates from previous years¹ and CPSC staff strongly recommends against any such comparison.

Because of the relatively small sample size, the annual fire estimates are shown as rounded to the nearest ten (instead of the customary 100). The injury estimates are also rounded to the nearest ten, the death estimates to the nearest 5 and the property loss estimates to the nearest tenth of a million dollars.

Table 1
Annual Estimated Residential Structure Fire Losses Resulting
From Cigarette Lighter Malfunctions

	Fires	Injuries	Deaths	Property Loss (in millions)
1999 [†]	110	10	0	\$0.0
2000	90	20	0	\$0.1
2001	70	20	0	\$0.4
2002	30	0	0	\$0.1
Total	290	50	0	\$0.7
Mean	70	10	0	\$0.2

Source: NFIRS and NFPA, 1999 – 2002

Note : Calculations of Total and Mean were based on un-rounded numbers. Hence sum not equal to total.

† : Revised since last report. To maintain consistency, estimates for 1999 were re-derived using the same methodology as used for 2000-2002.

¹ R. Chowdhury, CPSC, Division of Hazard Analysis, Directorate for Epidemiology, “Hazards Associated with Cigarette Lighter Malfunctions”. Memorandum to Rohit Khanna, January 13, 2004.

Estimated Injuries Treated in Hospital Emergency Rooms: The emergency room-based data show that there were an estimated 4,145 injuries (sample size = 98, cv=0.14) treated over the nine year period 1997 – 2005, that were caused by cigarette lighter malfunctions. The annual estimates are presented in Table 2 below. These annual estimates should be interpreted with caution since they are based on small sample sizes with large coefficients of variation associated with them.

Table 2
Annual Estimates of Emergency Room Treated Injuries Resulting From
Cigarette Lighter Malfunctions

	ESTIMATED INJURIES* (SAMPLE SIZE)	COEFFICIENT OF VARIATION	95% CONFIDENCE INTERVALS
1997	549 (13)	0.315	210 – 888
1998	433 (10)	0.421	76 – 790
1999	587 (12)	0.311	229 – 945
2000	724 (16)	0.304	293 – 1,155
2001	377 (10)	0.368	105 – 649
2002	345 (8)	0.383	86 – 604
2003	178(7)	0.500	4 – 352
2004	569(14)	0.329	202 – 936
2005	383(8)	0.394	87 – 679
Total	4,145 (98)	0.139	3,016 – 5,274
Mean	461 (11)		

Source: NEISS, 1997 – 2005

* Sample size shown in parenthesis

There were no deaths reported from the emergency room data. Over 94% of the injured were treated and released. A majority (about 83%) of the injuries were thermal burns. While various body parts were reported to have been injured, face, hand, and finger injuries accounted for nearly 79% of them. About 66% of the injured were males, while 34% were females. Nearly 83% of the victims were between 15 and 64 years of age. Table 3 below shows the breakdown of the total estimated injured persons by age groups. As with the annual estimates, these estimates should also be interpreted with caution since they are based on small sample sizes with large coefficients of variation associated with them.

The emergency room data indicate that a fire was involved in 32% of the injury-causing incidents. Fire department involvement was unrecorded in 60% of these fires; no fire department attended 39% of these fires while the remaining 1% was attended by fire departments.

Table 3
Age Distribution of Persons Treated at Emergency Rooms for Injuries Caused by Cigarette Lighter Malfunctions

AGE GROUPS	ESTIMATED NUMBER OF PERSONS	SAMPLE SIZE	COEFFICIENT OF VARIATION
0 - 4 years	11	2	0.655
5 - 14 years	557	15	0.361
15 - 24 years	1,151	28	0.263
25 - 44 years	1,548	31	0.255
45 - 64 years	724	16	0.308
65 years and over	133	5	0.587
Unknown	19	1	1.000
Total	4,145	98	0.139

Source : NEISS, 1997 - 2005

Note : Sum not equal to total due to rounding

Incidents from Other Sources: One death was identified from the DTHS file that may have involved a cigarette lighter malfunction. On March 10, 2001, a 76-year old woman died from 3rd degree burns to over 90% of her body. There were no witnesses to the incident. The report from the county sheriff's office concluded that the victim either accidentally ignited her clothing with the lighter while smoking or the lighter sprayed fuel onto her while she was lighting her cigarette.

Based on newspaper clippings, consumer complaints, medical examiners' reports and some in-depth investigation reports, a total of 362 incidents (an annual average of about 40 incidents) related to cigarette lighter failures were identified from 01/01/97 through 12/31/05. Sixty-nine of these incidents (around 19%) were followed up through in-depth investigations. Consumer complaints, consisting mostly of hotline calls and some written letters, accounted for 56% of the 362 reported incidents. An additional 25% of the incidents were reported through the CPSC web site using the Consumer Product Incident Report forms available online. While not a statistical sample of all incidents that occurred during the time period, these reports provide useful product-specific and scenario-specific detail.

In 214 of the 362 incidents, there were no injuries. The remaining 148 incidents involved 154 individuals. Four of the individuals died, 12 were hospitalized, 2 were transferred to different facilities, and the majority (125) were treated and released. The conditions of the remaining 11 persons were unknown.

Among the 154 individuals who were reported injured, 68 were known to be males and 73 females. Sixty-six percent of the individuals were in the 15 through 64 age group. There was a child under 5 with an injury; 5 injuries were sustained by 5 to 14 year olds and 9 injuries by individuals 65 years and older. Age was unknown for 25% of the persons injured. Gender and age information among the deceased is presented in Appendix 4.

Information on the extent of property damage was usually unavailable from these reports. Only 15 of the 362 incidents mentioned some property loss that ranged from minimal to \$125,000.

Failure Patterns: Based on information from the IPII and INDP files, explosion due to pressure or volumetric displacement was, by far, the most common type of malfunction in these lighter incidents². According to ASTM F-400, when the liquid portion of the lighter fuel exceeds 85% of the volumetric capacity of the fuel chamber or the lighter fails to adequately withstand internal vapor pressure, a fire or explosion can occur. From the incident scenario descriptions, it was evident that sometimes pressure or volumetric displacement led to a fire; at other times there was no fire but explosion itself presented a hazardous condition. The distribution of the hazard type by type of malfunction is shown in Table 4 below. Examples of typical incidents involving various types of malfunctions are provided in Appendix 2.

**Table 4
Distribution of the Type of Malfunction Identified in Cigarette Lighters**

TYPE OF MALFUNCTION	HAZARDS			TOTAL
	Fires	Explosions	Other	
Pressure / volumetric displacement	45	47	10	102
Failure to extinguish	49	0	7	56
Refilling: Fuel leakage / gas escapes	39	2	11	52
Flame control / height adjustment	42	2	3	47
Sparks / flaring / self-ignition	34	0	5	39
Failure to withstand extreme temperature	8	16	1	25
“Burning time” failure	9	4	2	15
“Drop test” failure	1	11	2	14
Other / unknown	8	0	4	12
TOTAL	235	82	45	362

Source: IPII and INDP, 1997-2005

Pressure or volumetric displacement malfunction led to all four deaths reported in the IPII and INDP incidents. In 3 of the 4 deaths, the victims were burned in fires that resulted from explosions; in the fourth case, the victim was burned as well but only “explosion” is indicated as the hazard type. In 7 of the 12 serious injuries needing hospitalization, lighters exploded causing fires. The other 5 individuals were also burn victims, but the fires were caused by other lighter failures. Detailed information on these incidents is provided in Appendix 3.

Products Involved: The product manufacturer/model information that was available from the 362 incident reports was not always complete or sufficient. In 293 cases, some information was

² Based on the incident narratives, it was not possible to determine whether the explosion was pressure or volume related.

available which allowed for the identification of about 70 different manufacturers/model brands. Only a handful of cases mentioned the country of origin.

Summary

The purpose of this data search was to document the hazards posed by mechanical failures of cigarette lighters. Based on the most recent data available from NFIRS, a total of 290 (an annual average of 70) residential structure fires were estimated for the period 1999 – 2002 that were caused by faulty cigarette lighters. While there were no deaths, there were an estimated 50 injuries associated with these fires and the property damage was estimated at 0.7 million dollars over the four-year period. Based on the most recent years with available NEISS data, 1997 – 2005, an estimated total of 4,145 injuries, mostly thermal burns to face, hands, and fingers, that were a result of malfunctioning cigarette lighters, were treated in hospital emergency rooms. Over 94% of the injured were treated and released. For the same time period, 362 incident reports related to cigarette lighter failures were received; 65% of these cigarette lighter failures resulted in fires, some leading to serious injuries and deaths. Of the many types of mechanical failures identified in these reports, pressure and volumetric displacements were the most common.

Appendix 1: Data Sources

NFIRS: The National Fire Incident Reporting System. This is the U.S. Fire Administration's voluntary data reporting system, containing incident reports from fire departments nationwide on fires that they attend. The data cover about 50% of all U.S. fires. At this time, 2002 is the latest year with available NFIRS data. For this search,

- Only non-incendiary and non-suspicious residential structure fires were included. For fire-related injuries and deaths, only non-fire fighters were included.
- For 1999-2002, the variables used were *Cause of Ignition* (code=3, Failure of Equipment or Heat Source), *Heat Source* (code=65, Cigarette Lighter), and *Factors Contributing to Ignition* (codes beginning with 2 and 4 indicating Mechanical Failure and Installation Deficiency and code=NN, indicating no factors contributed to ignition).
- The calculation of the proportion of residential structure fires and fire losses (injuries, deaths, and property damage) that were caused by faulty cigarette lighters was done separately for each year, from 1999 through 2002.
- These proportions were multiplied by the appropriate NFPA estimates of U.S. residential structure fires and fire losses to arrive at the national estimates of these fires and fire-related casualties. The National Fire Protection Association (NFPA) estimates the total number of fire incidents and the related fire losses such as injuries, deaths, and property loss in the U.S. based on their annual probability survey.
- Throughout the estimate-calculation process, any missing data were allocated proportionately to the known data using an iterative procedure known as raking.^{3,4}

NEISS: The National Electronic Injury Surveillance System. It is a probability sample of injuries treated at hospital emergency rooms around the nation. The sample consists of about 100 hospitals. Each record in the database pertains to an injury and includes information on the date of treatment, up to two codes to identify the product involved, the sample incident weight, and a narrative describing the incident. For this data search,

- At first stage, product codes for *Cigarette /Pipe Lighters* (1604) or *Lighters, Not Specified* (1687) with treatment dates between 01/01/1997 and 12/31/2005 were selected.

³ M.A. Greene, L.E. Smith, M.S. Levenson, S. Hiser, J.C. Mah. "Raking Fire Data". *Proceedings of the 2001 Federal Committee on Statistical Methodology Research Conference*. Arlington, VA, 2001.

⁴ Izrael, D., Hoaglin, D., Battaglia, M. A SAS Macro for Balancing a Weighted Sample. *SAS Users Group International (SUGI) 25th Annual Conference*. April 9-12, 2000, Indiana Convention Center, Indianapolis, Indiana. Paper 258-25.

- Second stage selection was based on careful examination of the narrative in each case to ensure that a cigarette lighter failure was indicated.
- The weights were then used to derive the national estimates of such injuries.

DTHS: This file contains death certificates that are bought by CPSC from all 50 states as well as Washington D.C. and New York City. Following the system of International Classification of Diseases, the external cause of death has been coded on the certificates for each death. The CPSC criteria for selecting the external codes to purchase depend on projects of interest. For this search,

- Data from 01/01/1997 through 12/31/2005 were selected where product codes were *Cigarette / Pipe Lighter* (1604) or *Lighter, Not Specified* (1687).
- The narratives of the above selected records were carefully examined to determine whether a cigarette lighter failure was indicated.

IPII: The Injury or Potential Injury Incident file. The data here are based on reports from newspaper clippings, consumer complaints, and medical examiner reports. The data are likely to include scenario specific detail such as hazard type, and product related detail such as manufacturer / model name and date of purchase. For this search,

- First stage selection was of incidents occurring between 01/01/1997 and 12/31/2005 where the product codes were *Cigarette / Pipe Lighter* (1604) or *Lighter, Not Specified* (1687).
- Second stage selection was based on careful scrutiny of the case narratives to include only the incidents where mechanical failure of the cigarette lighter was clearly indicated.

INDP: The In-Depth Investigation file. The data contain information from detailed investigation reports resulting from CPSC staff interest in particular product hazards. For this search,

- First stage selection was of incidents occurring between 01/01/1997 and 12/31/2005 where the product codes were *Cigarette / Pipe Lighter* (1604) or *Lighter, Not Specified* (1687).
- Second stage selection was based on careful scrutiny of the case narratives to include only the incidents where mechanical failure of the cigarette lighter was clearly indicated.
- Some of the records were in-depth investigations of the incident reports from IPII. Care was taken not to double count those cases.

Appendix 2: Examples of Different Types of Cigarette Lighter Malfunctions*

Document No.	Incident Date	Age/Sex	City/State	Injury / Body part	Malfunction	Hazard	Incident
N9730155A	02/01/97	72 / M	Asheville, NC	Burn / Back, neck, arms	Explosion from pressure / volumetric displacement	Explosion and fire	Victim sustained burn injuries when his cigarette lighter exploded as he tried to light a cigarette while walking down the street. His shirt then caught fire.
H9720118A	02/11/97	Unknown	Halifax, PA	None	Failure to extinguish	Fire	Whenever consumer lets go of plastic button from disposable cigarette lighter that holds gas to burn flames, button remains down, and flame continues to burn.
H9730226A	03/01/97	Unknown	Nashua, NH	None	Flame adjustment problem	Fire	Consumer noticed that flame from disposable lighter jumps up to 9" without flame adjustment and feels lighters present a burn / fire hazard.
H9730141A	03/14/97	63 / F	Tonawanda, NY	Burn / Finger	Other	Fire	The metal head detached on a disposable child resistant cigarette lighter and flames came from the area.
J98A0014A	03/16/97	Unknown/F	Washington, DC	Burn / Hair	Flaring	Fire	Victim's cigarette lighter flared up as she attempted to light a cigarette and ignited her hair.
H9780160A	08/15/97	52 / M	Marco Island, FL	Burn / Hand	Failure to withstand extreme temperature	Fire	The inside of a car ignited when a cigarette lighter was left on the passenger seat.
C99C0014A	01/01/99	Unknown	St. Louis, MO	None	"Burn time" failure	Fire	A cigarette lighter heats up during use and parts can launch off.
H0030344A	03/31/00	45 / F	St. Petersburg, FL	None	Refill - gas escape	Other	Complainant bought a hard plastic butane cigarette lighter. One hour later, lighter was out of fuel. She experienced shortness of breath and numbness in legs.
H0060343A	06/27/00	44 / F	Rocky Mount, NC	Bruise / Eye	"Drop test" failure	Explosion	A cigarette lighter had fallen to the ground and exploded. A piece of plastic projected from the lighter and hit the victim in the eye. She suffered a bruise on her left eye.

* The determination of malfunction and the classification of type of malfunction are based on staff review of available information; since testing was not conducted, this evaluation is not definitive.

Appendix 3: Hospitalized Injuries from Cigarette Lighter Malfunction Incidents; IPII& INDP, 1997-2005*

Document No.	Incident Date	Age/Sex	City/State	Injury / Body part	Malfunction	Hazard	Incident
981102HEP8213	10/28/98	10 / M	Columbus, OH	Burn / Arms, chin, chest	Flaring	Fire	The victim was trying to burn leaves with a lighter when the flame flared up and caught his shirt.
X0073124A	01/01/00	Unknown / M	Unknown, CA	Burn / Unknown	Flame control	Fire	Victim's lighter ignited fire ball while he was lighting a cigarette.
I0050084A		Unknown / M	Oakridge, TN	Burn / Unknown	Refill : fuel leakage	Fire	A faulty disposable butane cigarette lighter probably leaked butane, unknown to victim, onto his shirt. Shirt ignited when he lit the cigarette lighter.
020107HEP9001	12/20/01	40 / F	Brookville, OH	Burn / Face, hands	Explosion from pressure / volume displacement	Fire	The victim was injured while lighting a furnace at her home. When she lit the furnace with a lighter, it blew up and burned her face and hands.
G0240011A	03/21/02	85 / M	Clyde, OH	Burn / Hand, neck	Explosion from pressure / volume displacement	Explosion	Victim was injured after a cigarette was placed into an ashtray that also contained a lighter and the lighter blew up.
F0245015A	04/11/02	56 / F	Milwaukie, OR	Burn / Arm, side	Explosion from pressure / volume displacement	Fire	Victim attempted to light a cigarette with a lighter when the lighter exploded and fell into her pocket. Victim was burned along with her clothes.
F0390022A	08/06/03	22 / M	Glenwood Spring, CO	Burn / Unknown	Explosion from pressure / volume displacement	Fire	Victim hospitalized for severe burn after an explosion/fire at his mother's home. He had found an old lighter, ignited it, and everything blew up.
G03A0038A	09/08/03	50 / M	Salyersville KY	Burn / Chest, leg, face, arm	Explosion from pressure / volume displacement	Fire	Nursing home patient was hospitalized after a cigarette lighter exploded in his face.
040511HCC1680	04/25/04	14 / F	Concord, NC	Burn / Chest	Flame control	Fire	Victim, wearing an adult-sized T-shirt, flicked a disposable cigarette lighter and flames ignited her T-shirt.
G04B0045A	10/13/04	43 / M	Muskogee, OK	Burn / Unknown	Explosion from pressure / volume displacement	Fire	Victim suffered burns in an apartment fire. He had lighted a lighter when it blew up.
050301HEP5923	02/15/05	46 / M	Seattle, WA	Burn / Head	Unknown	Fire	Victim caught his hair on fire while lighting a cigarette.
050620HEP6721	06/16/05	18 / M	Piqua, OH	Burn / Hands, face	Explosion from pressure / volume displacement	Fire	Victim tried to light brush fire and the lighter blew up.

* The determination of malfunction and the classification of type of malfunction are based on staff review of available information; since testing was not conducted, this evaluation is not definitive.

Appendix 4: Deaths from Cigarette Lighter Malfunction Incidents; IPII & INDP, 1997-2005*

Document No.	Incident Date	Age/Sex	City/State	Fatal Injury	Malfunction	Hazard	Incident
000525CCC0704	12/08/99	80 / M	Portland, TN	Burn	Explosion from pressure / volume displacement	Fire	A disposable butane cigarette lighter exploded in the right front pocket of victim's overalls. He was in his yard at the time. No witnesses to the incident.
X0030840A	01/28/00	49 / M	Roxboro, NC	Burn	Explosion from pressure / volume displacement	Explosion	A cigarette lighter exploded in victim's shirt pocket.
F01B5003A	10/30/01	65 / M	Riverbank, CA	Burn	Explosion from pressure / volume displacement	Fire	The cigarette lighter that the victim was using exploded. As his clothes were burning, he ran from room to room setting a number of small fires. His wife turned the kitchen sink hose on him to extinguish his clothing flames. Victim expired eight days later.
X0373067A	02/08/03	49 / F	Kenosha, WI	Burn	Explosion from pressure / volume displacement	Fire	Victim died of burn injury received while lighting a cigarette with a cigarette lighter that exploded and ignited her robe and nightgown.

* The determination of malfunction and the classification of type of malfunction are based on staff review of available information; since testing was not conducted, this evaluation is not definitive.

TAB C



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum – For Official Use Only

Date: June 17, 2006

TO : Rohit Khanna, Project Manager, Petition CP 02-1
THROUGH: John Gibson Mullan, Director, EXC ^{verm}
FROM : Joe Vogel, Program Manager, CRC/FER ^N
SUBJECT : CP 02-1, Petition to Adopt ASTM F400-00 for Cigarette Lighters as a
Consumer Product Safety Standard under the Consumer Product Safety Act.

As a follow-up to a review of recalls of cigarette lighters (“lighters”) conducted between January 1973 and October 2003 (ref. memo dated February 26, 2004, attached), Office of Compliance staff reviewed recalls that were initiated since October 2003. We identified one additional recall pertinent to your project. Specifically, we conducted a recall for lighters, made in China, which caused injuries due to defects and/or failures covered by the voluntary standard for cigarette lighters, ASTM F400-00. The allegations included flaring and lighters ‘catching on fire.’ The recalling firm reported a total of six incidents involving approximately 500,000 affected lighters. Reported injuries included burn injuries to the head, hair, face and hand. There were no reports of grievous injuries or deaths associated with the recalled lighters.



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: February 26, 2004

TO : Rohit Khanna; Project Manager, Petition CP 02-1
THROUGH: Alan Schoem; Director, EXC *AAS*
FROM : Joe Vogel, Compliance Officer, CRC/FER *JV*
SUBJECT : CP 02-1, Petition to Adopt ASTM F400-00 for Cigarette Lighters as a
Consumer Product Safety Standard under the Consumer Product Safety Act.

Office of Compliance staff reviewed recalls of cigarette lighters ("lighters") conducted between January 1973 and October 2003. Of those approximately 55 recalls, nine were based on allegations of incidents and injuries, or potential injuries, due to defects and/or failures covered by the voluntary standard for cigarette lighters, ASTM F400-00. The allegations included high flames, failure to extinguish, flaring, gas leaks and explosions. The recalling firms reported a total of 38 incidents involving the recalled lighters. Reported injuries included burns, ranging from "minor" to second degree, and singed hair; property damage was also reported. There were no reports of grievous injuries or deaths associated with the recalled products.

The 38 alleged incidents - out of more than 15,300,000 lighters involved in the nine recalls identified above - occurred sporadically over the past approximately 30 years. There were few incidents resulting in recalls from January 1973 through September 1994 (7), two spikes in consumer complaints in the period October 1994 through December 1995 (27), and few incidents between January 1999 and December 2000 (4). There have been no recalls for issues addressed by ASTM F400-00 since approximately January 2001, although we were not actively looking for violations that might have resulted in recalls. **Figure 1** illustrates the number of incidents involving recalled lighters, which were allegedly due to problems addressed by ASTM F400-00.

The recalled lighters were manufactured in China, France, Holland and Korea, however, the country of origin could not be easily determined for four of the nine recalls. **Figure 2** shows the percentage of recalls per country of origin, where known.

The CPSC has not monitored conformance to the voluntary standard for cigarette lighters. Therefore, based on our evaluation of the lighter recalls conducted over the years, we do not know at this time whether lighter manufacturers, in general, are adhering to the voluntary lighter standard. We also do not know if the firms are producing, importing and/or distributing significant numbers of lighters with potential hazards addressed by the voluntary standard. Whether lighters that do not conform to the voluntary standard are defective and present a substantial product hazard would depend on the nature of the violation and risk of injury presented by the violation.

FIGURE 1

Reported Incidents Involving Lighters Recalled for Issues Addressed in ASTM F400

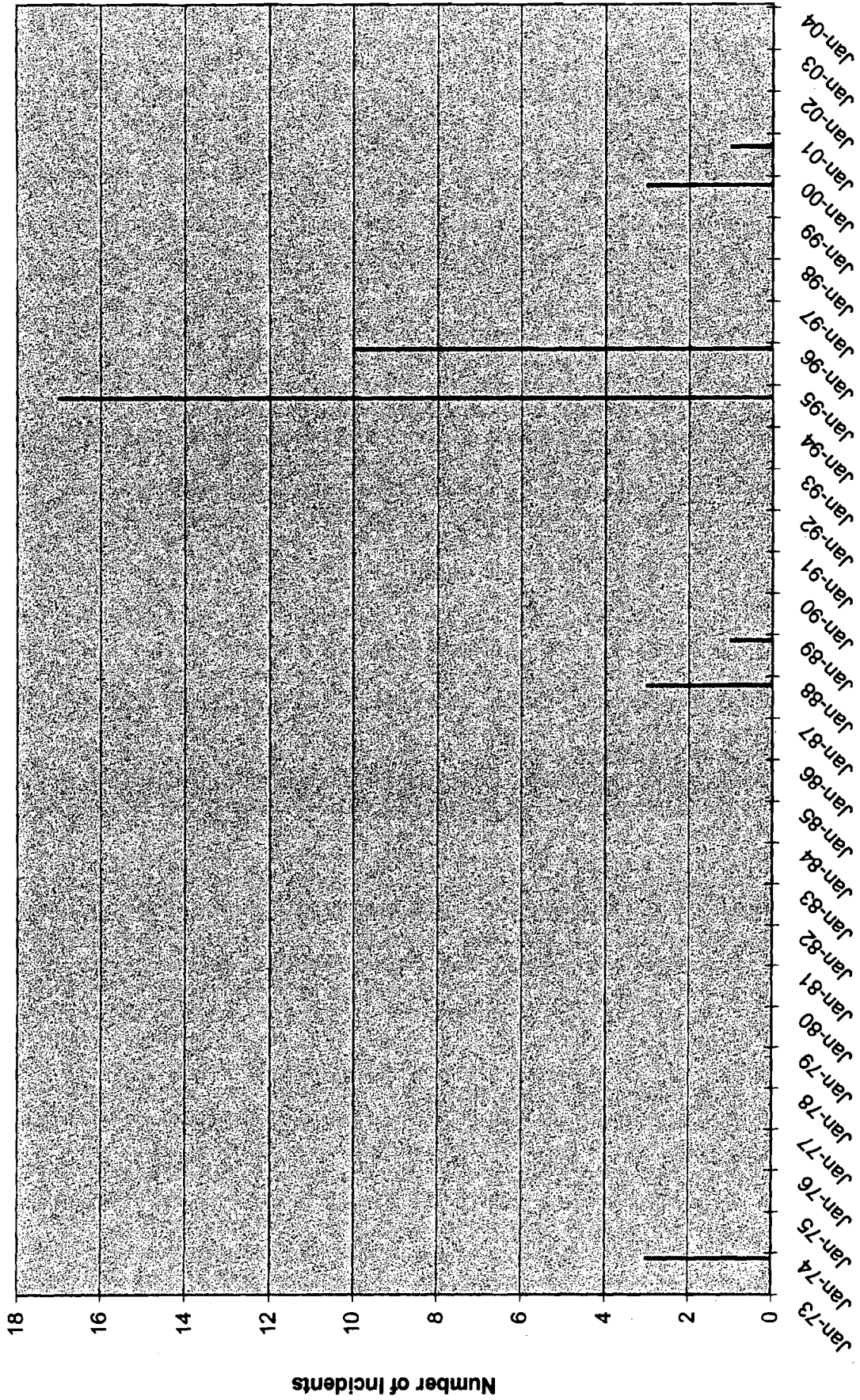
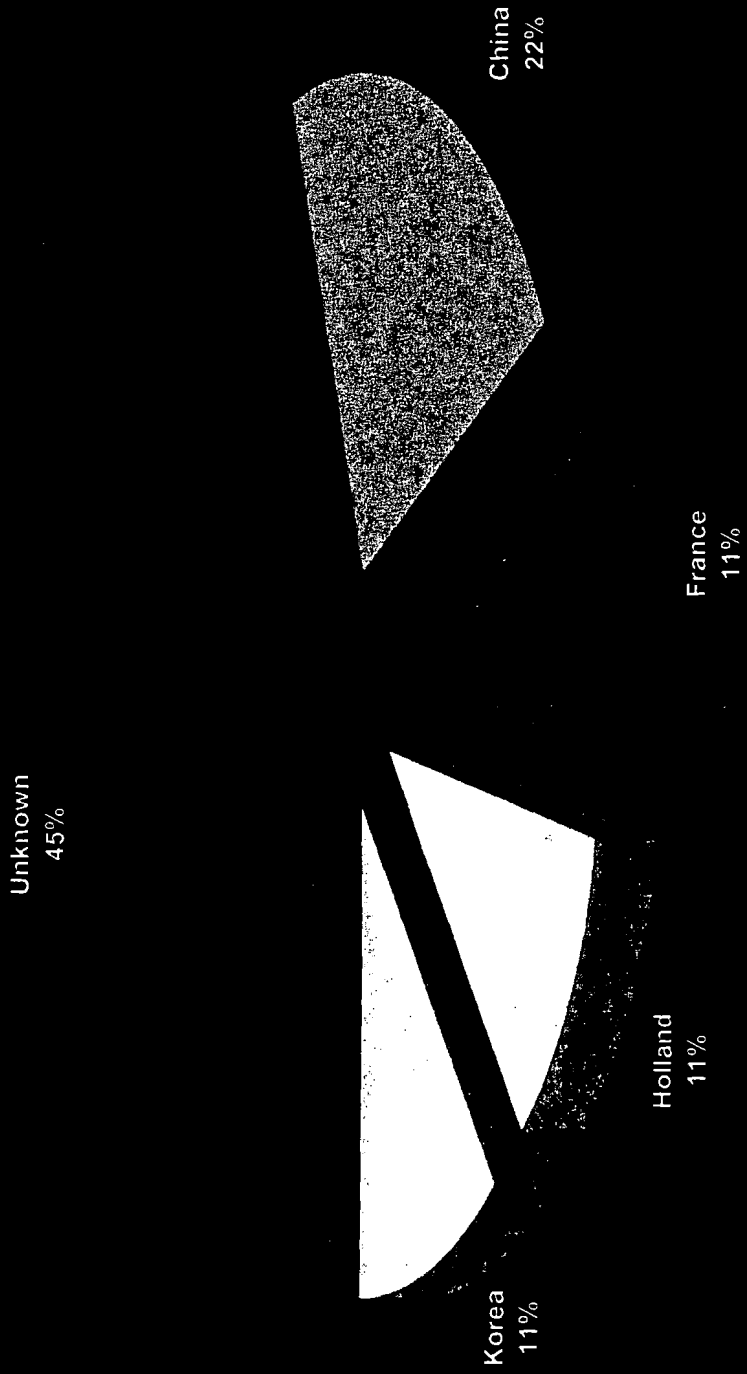


FIGURE 2

Recalls by Country of Origin



TAB D



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: July 25, 2006

TO : Rohit Khanna, Project Manager
Division of Combustion and Fire Sciences
Directorate for Engineering Sciences

THROUGH: Hugh McLaurin *HMK for HM*
Association Executive Director
Directorate for Engineering Sciences

FROM : Shivani Mehta, Project Engineer *SM*
Division of Combustion and Fire Sciences
Directorate for Engineering Sciences

SUBJECT : Engineering Analysis of Lighter Conformance Test Data

Introduction

In November 2004, the Commission voted to initiate rulemaking for the development of a safety standard to address the hazard of malfunctioning lighters. In support of this rulemaking proceeding, CPSC staff evaluated the U.S. market conformance to the existing voluntary standard, ASTM F-400, *Standard Consumer Safety Specification for Lighters*. This memorandum discusses the methodology used for the collection of lighters, a description of the samples collected, the basis for selecting lighters for conformance testing, and a preliminary analysis of the test results.

Sample Collection¹

In order to obtain lighter samples that are available in the U.S. market, Field staff from across the country was tasked with purchasing multiple lighters from various types of retail establishments.² Each Field staff member was instructed to purchase 15 distinct inexpensive lighter models and two distinct luxury (costing \$3.00 and over) lighter samples. The inexpensive samples were to be collected in a set of 30 units and the luxury samples in a set of 10 units.

As a result of this assignment, the Field staff collected 135 lighter samples from various types of retail establishments. By observing the appearance, markings, and/or packaging that accompanied the lighters, Engineering Sciences (ES) staff determined that of the 135 samples collected, 23 were duplicated. Omitting these duplicate samples, there were 92 distinct models collected.

The lighters are categorized in Table 1 by the following characteristics:

1. Price (Inexpensive/Luxury)
2. Disposable/Refillable

¹ A "Unit" is one lighter. A "Sample" refers to each set of units collected. "Model" refers to the specific manufacturer and design.

² Levenson, Mark, "ASTM F-400 Lighter Standard Conformance Study". September 23, 2005.

3. Adjustable/Non-Adjustable Flame Height Adjustment

Table 1. Division of samples by characteristics.

Category	Collected Samples	Distinct Models
Inexpensive, Disposable, Adjustable	75	45
Inexpensive, Disposable, Non-Adjustable	14	6
Inexpensive, Refillable, Adjustable	27	22
Luxury, Refillable, Adjustable	18	18
Luxury, Disposable, Adjustable	1	1
Total	135	92

The lighters can also be categorized by the country of manufacture for each of the categories above. The country was determined by the markings on the lighter.

Table 2. Division of samples by country of manufacture.

Category	Country	Collected Samples	Distinct Models
Inexpensive, Disposable, Adjustable	China	38	30
	France	4	1
	Mexico	12	4
	Spain	1	1
	Thailand	17	6
	Vietnam	1	1
	Unknown	2	2
Inexpensive, Disposable, Non-Adjustable	China	1	1
	France	4	2
	Spain	2	1
	USA	6	1
	Philippines	1	1
Inexpensive, Refillable, Adjustable	China	27	22
Luxury, Refillable, Adjustable	China	15	15
	USA	1	1
	Unknown	2	2
Luxury, Disposable, Adjustable	China	1	1
	Total	135	92

Lighter Selection Criteria for Conformance Testing

The lighter samples collected by Field staff provided a cross section of the market as a base to select from for conformance testing. Fifty samples were selected for testing per ASTM F-400 by a contractor, Bureau Veritas. In order to represent as many models and types of lighters as possible, the following decision process was applied in choosing the 50 samples for testing:

Decision 1: Randomly select test an example of each duplicated model.

Rationale: These models are found throughout the country and appear to be popular and readily available to consumers in the U.S. market.

Decision 2: Randomly select and test a model from each of the 17 country/category combinations, as seen in Table 2.

Rationale: Testing lighters from all countries identified will provide useful information to address the Lighter Association's assertion that non-member and foreign produced lighters do not conform to the voluntary standard.

Decision 3: Choose the remaining 33 models for testing by the approximate percentage that each country/category combination represents of the total distinct lighters collected.

Example: Disposable, Aadjustable, China (DAC): 30 distinct models
Number of samples to be tested = 33 models * (30 DAC /92 total distinct)
= 11 samples (rounded up) of DAC lighters to be tested.

Rationale: This approach will ensure that the samples sent for conformance testing reflect the types of lighters collected by Field staff by a percentage basis.

Decision 4: Limit the number of Luxury lighters to eight models. Choose models that range in cost and appearance.

Rationale: Disposable and refillable lighters are more commonly purchased by the consumer than the Luxury lighters. Therefore the test sample will more closely reflect the market.

Decision 5: Ensure that the lighters within each country/category combination range in price.

Rationale: This can assist in determining if there is a relation between price and conformance. Public comments have stated that "cheap" or "inexpensive" lighters are not likely to conform to the voluntary standard and implied that higher priced lighters do conform.

Decision 6: Choose lighters to represent as many companies (manufacturers or distributors) as possible.

Rationale: Selecting lighters from as many manufacturers and distributors as possible will aid in estimating market conformance.

Using these guidelines, 50 lighter samples were chosen as the test samples from the 92 distinct models collected by the Field staff. The distribution by country/category combination is shown in Table 3.

Table 3. Models to be tested divided by country/category combination.

Category	Country	Distinct Models	To be tested
Inexpensive, Disposable, Adjustable	China	30	12
	France	1	1
	Mexico	4	4
	Spain	1	1
	Thailand	6	6
	Vietnam	1	1
	Unknown	2	1
Inexpensive, Disposable, Non-adjustable	China	1	1
	France	2	2
	Spain	1	1
	USA	1	1
	Philippines	1	1
Inexpensive, Refillable, Adjustable	China	22	10
Luxury, Refillable, Adjustable	China	15	5
	USA	1	1
	Unknown	2	1
Luxury, Disposable, Adjustable	China	1	1
	Total	92	50

Testing

The 50 samples chosen were tested according to the applicable provisions of ASTM F-400. The standard specifies the performance of lighters during normal use and foreseeable misuse. The standard also specifies labeling for the lighters. For this study, the ES staff chose to focus on the provisions [“applicable provisions”] that address fire and explosion hazards. The application of provisions can depend on whether the lighter is gas or fluid fueled, adjustable or refillable. Within each provision for the gas fueled lighters, there are requirements and tests depending on whether the flame is a post-mixing or pre-mixing flame. Although a “hazardous condition” is not specifically defined in ASTM F-400, the implication is that it is a condition that can cause harm or injury to the user, e.g., a burn or injury from debris resulting in exploding pieces.

The following provisions apply to all lighters:

1. A deliberate action on the part of the user is required to activate a flame. (§4.1)
2. There is either a passive or active method by which the flame is adjusted. (§4.2)
3. The lighter is able to withstand a drop test and still operate properly.(§5.2)
4. The lighter is able to withstand a temperature of 65 °C for 4 hours and be able to perform normally without causing a hazardous condition. (§5.3)

5. The lighter is able to withstand a burning time of 5 seconds with the lighter in a position 45° below horizontal without causing a hazardous condition. (§5.4)
6. The lighter is able to withstand a burning time of 10 seconds with the lighter held in any position, 45° below horizontal, without causing a hazardous condition. (§5.4.1)
7. The lighter is able to withstand 2 minutes of continuous operation without causing a hazardous condition. (§5.5)
8. The lighter is able to withstand a burning time of 20 seconds, repeated 10 times, without causing a hazardous condition. (§5.6)
9. The lighter is able to be in contact with the recommended fuel without deteriorating. (§5.8)

In addition, gas lighters are required to be tested to the following provisions:

1. The lighter does not exhibit spitting, sputtering or flaring when set at the maximum flame height. (§4.4)
2. The lighter must not have an exposed flame within a given time once the flame is extinguished in the intended manner of the lighter. (§4.5)
3. The gas (in liquid form) in the lighter must not exceed 85% of the volumetric capacity of the fuel chamber. (§4.6)
4. The lighter is able to withstand an internal pressure of two times the vapor pressure occurring at 55 °C of the recommended fuel. (§5.9)

All adjustable height lighters require a deliberate action to increase the flame height. This provision also requires that the direction of adjustment be imprinted on the lighter. (§4.3)

All refillable fluid lighters are required to be free from fuel leakage from the sealed reservoir and the sealing closure. (§6.2)

All refillable gas lighters: the refilling valve in a pressurized fuel reservoir must not allow gas leakage greater than 15 mg/min. (§6.4)

The ASTM F-400 standard does not provide requirements on the sample size to be tested or the number of units that should be tested per provision. Since the CPSC staff study was focused on obtaining lighters directly from retail establishments, the Field staff was instructed to collect samples of 30 lighters units (10 for luxury lighters) since that was determined to be a reasonable amount to find in retail. A statistical sampling plan for testing each sample was not followed because the total numbers of lighters manufactured of each model would have to be known.

The CPSC staff relied on the past experiences of the contractor, Bureau Veritas, to make the determination of the number units to be tested per test provision. Table 4 shows the breakdown of testing depending on how many units were collected in each sample. For example, if a sample was made up of 11 units, 10 of those units would be tested per sections 4.1 through 4.4, one lighter would be tested per section 4.6, two lighters would be tested per section 5.2, and so on. A unit can be tested to multiple provisions if it hasn't been destroyed in previous tests. It should be noted that if, early in the testing scheme, units failed and were not available for further testing, the scheme was adjusted to test the available units. Within the sample, the units were chosen at random to be tested per the applicable provisions.

Table 4. Number of units to be tested according to sample size.

Number of Units in Sample	Performance (§4.1-4.5)	Volumetric (§4.6)	Drop Test (§5.2)	Temperature Test (§5.3)	Burning Test (§5.4)	Continuous Burn (§5.5)	Cycling Burn (§5.6)	Compatibility (§5.8)	Pressure Test (§5.9)	Refilling (§6.2, §6.4)
10	9	1	2	1	4	4	4	1	1	1
11	10	1	2	1	4	4	4	1	1	1
22	21	1	4	1	10	10	10	1	1	1
25	24	1	4	1	11	11	11	1	1	1
28	27	1	4	2	13	13	13	1	2	1
29	28	1	4	2	13	13	13	1	2	1
30	29	1	4	3	14	14	14	1	3	1
32	31	1	4	3	15	15	15	1	3	1

Pass/Fail Criteria

The ASTM F-400 standard does not provide criteria for passing or failing the standard as a whole. There is also no language that discusses allowed failures of the individual provisions.

If each lighter in a model that was manufactured was examined for conformance to the ASTM F-400 standard, one would expect to encounter a reasonable number of non-conformances due to variability in materials and processes. This data would aid in developing a procedure to address the non-conforming models based on their production characteristics. However, due to the small sample size of the models, this type of analysis cannot be done. Consequently, for the purposes of this evaluation, any lighter failing an applicable provision by any number of units was counted as failing the standard.

Results

The data was compiled by sample tested. The number of units failing each provision was recorded. Of the 50 samples that were tested, 28 had units failing one or more applicable test provisions. The breakdown of failures is tabulated in Table 5. The Inexpensive, Disposable, Adjustable lighter category and the Inexpensive, Refillable, Adjustable category had greater failure rates than lighters in other categories.

Table 5. Failures by category.

Category	Samples Collected	Distinct Models	Tested	Failed
Inexpensive, Disposable, Adjustable	75	45	26	17
Inexpensive, Disposable, Non - Adjustable	14	6	6	1
Inexpensive, Refillable, Adjustable	27	22	10	7
Luxury, Refillable, Adjustable	18	18	7	3
Luxury, Disposable, Adjustable	1	1	1	-
Total	135	92	50	28

Failures by Country

One of the concerns of the Lighter Association, according to their tests, is that non-member firms producing lighters in China do not meet the requirements of the voluntary industry safety standard. Table 6 supports this assertion, as the majority of the tested and failed lighters are from China. Samples from other countries of manufacture also demonstrated a non-conformance to the requirements of ASTM F-400.³

Table 6. Failures by country.

Country	Samples Collected	Distinct Models	Tested	Failed
China	82	69	29	20
France	8	3	3	-
Mexico	12	4	4	2
Philippines	1	1	1	-
Spain	3	2	2	1
Thailand	17	6	6	3
Unknown	4	4	2	2
USA	7	2	2	-
Vietnam	1	1	1	-
Total	135	92	50	28

³ It should be noted that the number of samples tested is not necessarily a representation of that country of manufacture in the U.S. market.

Failure by Lighter Association Members

According to the Lighter Association, lighters manufactured by its members conform to the ASTM F-400 standard. As such, it is important to examine the conformance of the members' lighters represented in this study. There were four failures of the 15 Lighter Association members' samples tested. In contrast, 24 of the 35 non-members' samples failed.

Table 7. Lighter Association member lighter failures.

Membership Status	Samples Collected	Distinct Models	Tested	Failed
Lighter Association member	42	15	15	4
Non- Lighter Association member	93	77	35	24
Total	135	92	50	28

Table 8. Lighter Association member lighter failures by country.

Country	Samples Collected	Distinct Models	Tested	Failed
China	—	—	—	—
France	8	3	3	—
Mexico	12	4	4	2
Philippines	1	1	1	—
Spain	2	1	1	—
Thailand	11	3	3	1
Unknown	1	1	1	1
USA	7	2	2	—
Vietnam	—	—	—	—
Total	42	15	15	4

Failures by Provision

Another way to view lighter conformance is by provisions of ASTM F-400. Conformance of both samples and units within samples is described below. Within many of the samples, multiple units failed various provisions.

Table 9. Samples and units failing provisions of ASTM F-400 standard.

Total Provisions Failed	Samples Failed	Units Failed
1	13	28
2	5	29
3	6	50
4	2	28
5	2	26
Total	28	161

As can be seen from Table 9, samples which failed multiple provisions had many units failing. The samples which did not fail many provisions had fewer lighters failing these provisions.

Table 10. Failures by ASTM F-400 test provision.

Test Provision	Samples Failed	Units Failed	Samples Failing only this provision
4.2 - Flame control	1	1	
4.2.3 - Adjustable, post-mix lighter maximum flame height	5	40	
4.2.4- Adjustable, pre-mix lighter maximum flame height	1	5	
4.2.5- Adjustable, post-mix lighter, initial use height	1	1	1
4.2.7 - All adjustable lighter minimum height	1	1	
4.3 – Flame height adjustment			
4.3.4 - Indication of adjustment direction	2	35	1
4.4 - Spitting or Sputtering and Flaring	10	31	1
4.6 - Volumetric displacement	14	14	5
5.2 - Drop test			
5.2.1 - Lighter (kept at 23°C) drop test without safe operation adjustment	2	3	1
5.2.1 - Lighter (kept at -10°C) drop test without safe operation adjustment	2	2	
5.3 - Temperature test	4	7	
5.3.1 - Lighter meets all of section 4 after withstanding 65°C	2	2	
5.5 - Continuous burn	5	6	
5.6 - Cycling burn	2	4	
5.8 – Compatibility	1	1	
5.9 - Pressure test	5	6	
6.4 – Refilling	1	4	

The failures occurred in many of the provision sections as shown in Table 10. As seen in the last column, nine sample failures occurred with only one unit failing one test provision.

The provision failed most frequently was §4.6, *Volumetric Displacement*, with 14 samples failing. This provision determines if the fuel chamber was overfilled. Overfilling of the chamber can lead to increased internal pressure, causing an explosion hazard. The internal pressure that a lighter can withstand also affects the potential explosion hazard of the lighter. This is examined in §5.9, *Pressure Tests*, in which the fuel reservoir is pressurized to twice the vapor pressure of the fuel, calculated at an elevated temperature. If a unit cannot withstand this pressure, the risk of explosion is present. Previous analysis of incidents reported indicated that

explosion or fire due to pressure or volumetric displacement was the most common type of malfunction in these lighter incidents.⁴

The second most failed provision was §4.4, *Spitting or Sputtering and Flaring*, with 10 samples demonstrating unacceptable performance. Spitting occurs when unburned gas separates from the main flame and is characterized by the eruption of small flames from the lighter. When the flame is not a constant shape and size, almost flickering, that is described as “sputtering”. When the flame suddenly bursts, that is described as “flaring”. If the flame exhibits any of these behaviors, the mechanism that creates the flame is not properly designed. While in use, the flame can present a hazard as these behaviors are not reasonably foreseeable to the user and may burn the user or ignite a nearby combustible material. This type of failure accounted for about 10 percent of fires and explosions reported between 1997 and 2005.⁴

Provisions §4.2 and §4.3 examine lighters for issues related to flame height. These provisions are significant for this study based on the information gained from reported fires and explosions between 1997 and 2005.⁴ Malfunctions with flame control and adjustment accounted for about 13 percent of the malfunctions identified in these incidents. Provision §4.2 observes the maximum flame heights of the lighters under different adjustments.⁵ It is important to examine the flame heights of cigarette lighters as they are used close to the face. Two samples failed the provision (§4.3) that requires that an adjustable lighter be imprinted with the direction of adjustment.⁶ This indication is important to aid the user in identifying if the adjustment will produce a larger or smaller flame.

The other provisions are also important because each one addresses a type of failure that was reported in the incidents, although less frequently.⁴

Conclusion

A program was initiated to determine the conformance to ASTM F-400 of cigarette lighters in the U.S. market. CPSC Field staff obtained 135 lighter samples from various retail outlets to use in the conformance study. ES staff sent 50 samples representative of the collection to an outside testing laboratory for evaluation per ASTM F-400. This subset of lighter samples included models manufactured in China, France, Spain, the United States, Thailand, Vietnam, the Philippines and Mexico.

The provisions of the ASTM F-400 standard addressing fire and explosion hazards were identified, and lighter performance under those provisions was analyzed by ES staff. A failure rating was assigned to a lighter sample if any unit of the sample failed any applicable provision at least once. The analysis indicates that approximately half of the samples tested do not conform to the voluntary standard. The majority of lighter samples that failed were imported from China.

⁴ R. Chowdhury, CPSC., Division of Hazard Analysis, Directorate for Epidemiology, “Hazards Associated with Cigarette Lighter Malfunctions-Update”. Memorandum to Rohit Khanna, June 23, 2006.

⁵ If the lighter was non-adjustable, it was tested on the factory set flame height.

⁶ Since none of the units in the sample set had the adjustment distinction on it, the sample was tested as a non-adjustable lighter.

The test data obtained in this study also coincides with reported incidents involving mechanical malfunctions of lighters between 1997 and 2005. The three ASTM F-400 provisions failed most frequently in the study (pressure and volumetric displacement, flame control, and spitting/sputtering/flaring) correspond to major types of malfunctions identified in the fire incidents.

The directorates for Epidemiology and Economic Analysis used this test data in a more comprehensive analysis to determine a level of conformance of both the sample collection and of the U.S. market.

TAB E



UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: July 24, 2006

TO : Rohit Khanna, Project Manager
Directorate for Engineering Sciences

THROUGH: Russell Roegner, Ph.D. *RR*
Associate Executive Director
Directorate for Epidemiology

Kathleen Stralka *KS*
Director
Division of Hazard Analysis

FROM: Risana Chowdhury *R.C.*
Division of Hazard Analysis

SUBJECT : Sample Conformance Rates Based on ASTM F-400 Lighter Test Data*

Background

In November 2004, the U.S. Consumer Product Safety Commission (CPSC) voted to initiate rulemaking for the development of a safety standard to address the hazard of mechanical failures in cigarette lighters. In support of this rulemaking, CPSC staff began a study to evaluate the U.S. market conformance to the existing voluntary standard, ASTM F-400, *Standard Consumer Safety Specification for Lighters*. This memo presents the level of conformance to the voluntary standard of a subset of cigarette lighters collected for conformance testing. The sample conformance rates derived in this memo will be used by EC staff to estimate the U.S. market conformance levels.

Collected Samples

Using a convenience sampling scheme, CPSC Field staff collected 135 lighter samples from across the country and various types of retail establishments¹. By observing the appearance of the lighters, the markings on the lighters and/or packaging that accompanied the lighters, ES staff determined that 92 of the 135 samples collected were distinct models that could be used for

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

¹ R.Khanna, M.Levenson, B.Schwartz, U.S. Consumer Product Safety Commission, "ASTM F-400 Lighter Standard Conformance Study", September 23, 2005.

conformance testing. These 92 distinct samples were categorized by the following property combinations:

- Price – Inexpensive (less than \$3.00) / Luxury (\$3.00 and over)
- Disposable/Refillable
- Flame Height Adjustment - Adjustable/Non-Adjustable flames, and
- Country of Manufacture

Selection of Lighter Samples for Conformance Testing

ES staff delineated a decision process² by which 50 samples were selected for conformance testing. The details are shown in Table 1 below.

Table 1. Distribution of Samples by Category/Country Combinations

Category	Country	Samples Collected	Distinct Samples	Samples Tested
Inexpensive, Disposable, Adjustable	China	38	30	12
	Thailand	17	6	6
	Mexico	12	4	4
	France	4	1	1
	Spain	1	1	1
	Vietnam	1	1	1
	Unknown	2	2	1
Inexpensive, Disposable, Non-Adjustable	USA	6	1	1
	France	4	2	2
	Spain	2	1	1
	Philippines	1	1	1
	China	1	1	1
Inexpensive, Refillable, Adjustable	China	27	22	10
Luxury, Refillable, Adjustable	China	15	15	5
	USA	1	1	1
	Unknown	2	2	1
Luxury, Disposable, Adjustable	China	1	1	1
	Total	135	92	50

Source: ASTM F-400 Lighter Standard Test data, U. S. Consumer Product Safety Commission, 2006.

² S. Mehta, ES, CPSC, “ASTM F-400 Lighter Standard Conformance Study”, July 2006.

Conformance Testing

As per ASTM F-400 requirements, a minimum of 10 lighter units of a sample are required to test all the provisions of the standard once. As such, the lighters were collected in lots of at least 10 units – 10 for luxury lighters, 30 for inexpensive lighters. Bureau Veritas, a contractor laboratory facility, conducted the testing. CPSC Engineering staff analyzed and compiled the test results and forwarded the results to EPHA staff for conformance rate calculations. Four measures of conformance were of interest:

- Overall conformance rate
- Conformance rate by categories shown in Table 1 above
- Conformance rate by country of manufacture
- Conformance rate by Lighter Association membership (overall and by country of manufacture).

Results

The overall sample conformance rate was determined to be 45%. The methodology used for calculating the conformance rates is detailed in the Appendix.

Table 2 below shows the conformance rates by the different categories which reflect the price of the lighter, whether the lighter is disposable or refillable, and the provision for flame height adjustment. In the category of luxury, disposable, and adjustable lighters, only 1 sample was tested. Hence, the resulting rate of 100% conformance must be interpreted with caution.

Table 2: Conformance Rate by Category

Category	Samples Collected	Samples Tested	Passed	Conformance Rate
Inexpensive, Disposable, Adjustable	75	26	9	34%
Inexpensive, Disposable, Non-adjustable	14	6	5	93%
Inexpensive, Refillable, Adjustable	27	10	3	40%
Luxury, Refillable, Adjustable	18	7	4	56%
Luxury, Disposable, Adjustable	1	1	1	100%
TOTAL	135	50	22	

Source: ASTM F-400 Lighter Standard Test data, U.S. Consumer Product Safety Commission, 2006

Table 3 below shows the conformance rate by the country of manufacture. Samples from countries which contributed less than 1% of U.S. imports in 2005 (according to the U.S. Census Bureau) were grouped together under the “Other” category. As noted earlier for Table 2,

conformance rates in Table 3 which are based on results from only a few tested samples must be interpreted with caution.

Table 3: Conformance Rate by Country

Country	Samples Collected	Samples Tested	Passed	Conformance Rate
China	82	29	9	30%
Thailand	17	6	3	65%
Mexico	12	4	2	50%
France	8	3	3	100%
USA	7	2	2	100%
Spain	3	2	1	67%
Other (Vietnam, Philippines)/Unknown	6	4	2	33%
TOTAL	135	50	22	

Source: ASTM F-400 Lighter Standard Test data, U.S. Consumer Product Safety Commission, 2006

Table 4 below shows the conformance rate of cigarette lighters by the membership status of their manufacturers in the Lighter Association, Inc. distributed by the country of the manufacture.

Table 4: Conformance Rate by Lighter Association Membership and Country of Manufacture

Membership Status of Manufacturer	Country	Samples Collected	Samples Tested	Passed	Conformance Rate
Lighter Association Members	Mexico	12	4	2	50%
	Thailand	11	3	2	82%
	France	8	3	3	100%
	USA	7	2	2	100%
	Spain	2	1	1	100%
	Philippines	1	1	1	100%
	Unknown	1	1	0	0%
	Overall	42	15	11	79%
Non-Members	China	82	29	9	30%
	Thailand	6	3	1	33%
	Spain	1	1	0	0%
	Vietnam	1	1	1	100%
	Unknown	3	1	0	0%
	Overall	93	35	11	30%

Source: ASTM F-400 Lighter Standard Test data, U.S. Consumer Product Safety Commission, 2006

APPENDIX Methodology

During the sample collection process, lighters from the same manufacturer were often collected more than once. However, once duplicates were identified, the samples selected for testing were all distinct.

1. Within each membership/category/country combination, each tested sample was assigned a selection proportion, p , which took into consideration all of the duplicities among the collected samples.
2. Based on the test results, each tested sample was either assigned a “pass” (value 1) or “fail” (value 0) score.
3. By combining the selection proportion with the pass/fail score, a weight was computed for each tested sample as $w = p*k/n$, where
 p = selection proportion for the sample
 $k = 0$ or 1 if sample failed or passed, and
 $n = 1$ always (since only 1 sample was tested)
4. The conformance rate for each membership/category/country combination was the aggregated weights from all samples tested within that combination. This can be represented as
 $r_i = \sum w_i$, where
 $i = 1 \dots I$, represents a sample within a level in the membership/category/country combination,
 w_i = weight for i th sample within that membership/category/country combination.

To illustrate this with an example, consider the 12 collected lighter samples in the “inexpensive, disposable, adjustable” category, from Mexico whose manufacturers are Lighter Association (LA) members. The table below illustrates steps 1 - 4 described above. Samples that are duplicates are shown grouped together.

Sample #	Tested	Passed	Selection proportion, p	Sample weight, w
05-810-2728	Yes	1 (Yes)	4/12 [†]	1*(4/12) = 0.3333
05-810-2254			n/a since not selected for testing	n/a
05-830-4187			n/a	n/a
05-830-5386			n/a	n/a
05-810-2726	Yes	0 (No)	4/12	0*(4/12) = 0
05-830-4190			n/a	n/a
05-840-6216			n/a	n/a
06-840-6127			n/a	n/a
06-830-5553	Yes	1 (Yes)	2/12	1*(2/12) = 0.1667
05-810-2727			n/a	n/a
05-830-5383	Yes	0 (No)	2/12	0*(2/12) = 0
05-810-2729			n/a	n/a
Conformance rate, r, for inexpensive, disposable, adjustable lighters from Mexico whose manufacturers are LA members =				0.3333+0+0.1667+0= 0.5

[†]4/12 since 4 of the 12 collected samples are similar to each other.

5. The overall conformance rate = $\sum c_j * r_j$, where
 $j = 1 \dots 19$, represents the membership/category/country combinations
 $c_j = (\# \text{ of samples collected in } j\text{th membership/category/country combination}) / (135, \text{ total } \# \text{ samples collected})$ and
 $r_j = \text{as defined in step 4 above.}$

The table below illustrates the calculations for overall conformance rate. For brevity, not all entries are shown.

Membership	Category	Country	Samples collected	Conformance rate, r	c*r
Non-Lighter Association (Non-LA)	Inexpensive, disposable, adjustable (IDA)	China	38	0.1	$(38/135) * (0.1) = 0.0281$
LA	IDA	France	4	1	$(4/135) * (1) = 0.0296$
LA	IDA	Mexico	12	0.5	$(12/135) * (0.5) = 0.0444$
...
...
...
...
	Total		135		
Overall conformance rate =					0.0281+0.0296+0.0444+...=0.45

6. The "category" conformance rate = $\sum s_l * r_l$, where
 $l = 1 \dots L$, represents the membership/country combinations within a category
 $s_l = (\# \text{ of samples collected within } l\text{th membership/country combination in that category}) / (\text{total } \# \text{ of samples collected in that category})$ and
 $r_l = \text{as defined in step 4 above.}$

The calculations for the category "inexpensive, disposable, adjustable" (IDA) are illustrated in the table below. Again for brevity, not all entries are shown.

Category	Membership	Country	Samples collected	Conformance rate, r	s*r
IDA	Non-LA	China	38	0.1	$(38/75) * 0.1 = 0.0507$
IDA	LA	France	4	1	$(4/75) * 1 = 0.0533$
IDA	LA	Mexico	12	0.5	$(12/75) * 0.5 = 0.0800$
...
Total			75		
Category (IDA) conformance rate =					0.0507+0.0533+0.08+...=0.34

7. The “country” conformance rate = $\sum q_m * r_m$, where $m = 1, \dots, M$, represents the membership/category combination within a country $q_m = (\# \text{ of samples collected within } m\text{th membership/category combination in that country}) / (\text{total } \# \text{ of samples collected in that country})$ and $r_m =$ as defined in step 4 above.

The calculations for the country China are illustrated in the table below. Again for brevity, not all entries are shown.

Country	Membership	Category	Samples collected	Conformance rate, r	$q*r$
China	Non-LA	Inexpensive, disposable, adjustable	38	0.1	$(38/82)*0.1=0.0463$
China	Non-LA	Inexpensive, disposable, nonadjustable	1	0	$(1/82)*0=0$
China	Non-LA	Inexpensive, refillable, adjustable	27	0.4	$(27/82)*0.4=0.1317$
...
Total			82		
Conformance rate for China =					0.0463+0+0.1317+...= 0.30

8. The methods used for computing the conformance rates by Lighter Association membership and by country of manufacture within each membership status follow many of the same steps described in the preceding sections.

For the country-specific rates, the 19 membership/country/category combinations are regrouped such that all samples from the same country (irrespective of categories) that are LA (or non-LA) members are contiguous. The conformance rate for each country is computed as the weighted average of r_i (as defined in step 4 above) where the category proportions (e.g., inexpensive, disposable, adjustable lighter samples collected) for that country represent the weights.

The calculations for the country France (LA members) is illustrated below.

Membership	Country	Category	Samples collected	Conformance rate, r	Weighted rate
LA	France	Inexpensive, disposable, adjustable	4	1.0	$(4/8)*1.0=0.5$
LA	France	Inexpensive, disposable, nonadjustable	4	1.0	$(4/8)*1.0=0.5$
	Total		8		
Conformance rate for Lighter Association members from France =					0.5+0.5=1.00

The conformance rate for LA (or non-LA) members is the weighted average of the country-specific rates with the proportion of samples collected from each country representing the weights. The calculations are illustrated in the table below.

Membership	Country	Samples collected	Country-specific conformance rate	Weighted rate
LA	Mexico	12	0.5	$(12/42)*0.5=0.1429$
LA	Thailand	11	0.8182	$(11/42)*0.8182=0.2143$
...
Total		42		
Conformance rate for LA members =				$0.1429+0.2143+...=0.79$
Non-LA	China	82	0.3	$(82/93)*0.3=0.2645$
Non-LA	Thailand	6	0.3333	$(6/93)*0.3333=0.0215$
...
Total		93		
Conformance rate for non-LA members =				$0.2645+0.0215+...=0.30$

Since the cigarette lighter collection process followed more of a convenience sampling scheme than a statistical sample, no statistical inferences (such as confidence intervals associated with the conformance rates) are presented.