Tab H

Involvement of Bedclothes in Residential Mattress Fires

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Executive Summary

In support of the Consumer Product Safety Commission's staff evaluation of the need for a possible flammability standard for bedclothes, this report was prepared to present the most recent available data on the involvement of bedclothes in mattress fires. In particular, this report provides information on the role of various bedclothes items as a contributor to mattress and bedding fires.

The primary findings are as follows:

- Available data indicate that a bedclothes item was the item first ignited in about 80 percent of mattress and bedding fires.

- Once a fire was ignited, most bedclothes items that were present ignited at some point in the ensuing fire.

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

I. Background

Estimates of mattress and bedding fires attended by the fire services are based on the U.S. Fire Administration's National Fire Incident Reporting System data and the National Fire Protection Association's annual survey. The most recent national fire loss estimates indicated that mattresses and bedding were the first items to ignite in 19,400 residential fires attended by the fire service annually during 1995 – 1999.[1] These fires resulted in 440 deaths, 2,230 injuries and $273.9 million in property loss each year. Open flame ignition sources accounted for 35 percent of these fires and smoking material sources accounted for 30 percent of the fires. The remaining fires included a variety of ignition sources including heat sources too close to the bed. Based on these data alone, it is very difficult to determine whether the first item ignited was a mattress or a bedclothes item.

The mattress industry recently funded testing at the National Institute of Standards and Technology (NIST) to explore the effects of bedclothes ignition and the methods for controlling heat release from mattresses.[2] The results indicated that some bedclothes can produce peak heat release rates high enough to create flashover conditions even without the involvement of the mattress. The State of California has conducted testing of mattresses and bedding with the intent of supporting California TB 603, an ignition standard for mattresses which is expected to take effect in January 2005, and TB 604, an ignition standard for selected bedclothes which is still in development.

In October 2001, the Consumer Product Safety Commission (CPSC) issued an Advance Notice of Proposed Rulemaking to address open flame ignition of mattresses. Many comments were received, both for and against the inclusion of tests on bedclothes. This report was prepared to provide the most recent data available on the involvement of bedclothes in mattress fires.

II. Methodology

CPSC investigations of individual fires are the primary source for information on the involvement of various bedclothes items in mattress fires. These investigations were based on a variety of initial sources, NEISS hospital emergency room reports[3], newspaper clippings, and fire department reports. Because the level of detail that identifies the involvement of mattresses and bedding may not be cited in the initial reporting document, many incidents were investigated as a result of other CPSC activities. For example, many investigations were conducted as a result of CPSC interest in candles or lighters and the involvement of a mattress or bedding was apparent only when the investigation was completed. This data set includes a total of 241 investigated fires that occurred between

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[1] Smith, Linda and Miller, David, Residential Fires Involving Mattresses and Bedding, August 2004, Table 1.

[2] Ohlemiller, TJ et al, "Flammability Assessment Methodology for Mattresses." NISTIR 6497, June 2000 and Ohlemiller, TJ and Gann, RG, "Estimating Reduced Fire Risk From an Improved Mattress Flammability Standard,", NIST Technical Note 1446, August 2002.

[3] NEISS is a probability sample of product-related injuries treated in hospital emergency rooms. NEISS is operated by the CPSC.

January 2000 and June 2003. All investigated incidents are documented by CPSC Epidemiologic Investigation Reports and are included in CPSC's INDP database. The search criteria used to identify the incidents are included in Appendix A.

Unless someone witnessed fire ignition, it was often difficult to determine whether the mattress or a bedclothes item, such as a pillow or blanket, ignited first. When the initial ignition was not observed and reported, the decision of what ignited first was based on the reported scenario. For example, if a lamp fell on a blanket on the top surface of the bed, the incident was classified as igniting the blanket first. When a child was using a lighter to look for something under the bed and it was known that a box spring was present, the incident was classified as igniting the box spring first unless the report stated otherwise. Often an incident involved so much damage that all mattress and bedclothes items except the metal springs were completely destroyed. Although investigators attempted to talk to the occupants to learn about the type and number of bedclothes items present, investigators often were unable to locate the occupants who may have moved out of the dwelling. As a result, product detail frequently was absent.

In view of the assignment criteria represented here, the distribution of smoking material fires versus open flame fires among the non-NEISS incidents cannot be considered representative of national mattress/bedding fires. Nonetheless, there appears to be no reason to believe that the reported bedclothes items involved would not be representative of bedclothes present in mattress and bedding fires generally.

III. Results

A. Fire Scenarios

Among the 241 investigated fire incidents included here, 144 involved ignitions caused by small open flames, predominantly from candles or lighters (Table 1). Ignitions caused by smoking materials and heat conducted from operating equipment each accounted for 33 incidents. Most of the remaining fires were caused by electric blankets. As discussed earlier, this distribution should not be construed as indicative of the heat sources involved in mattress and bedclothes fires overall.

Small open flame fires were caused predominantly by children playing, mostly with cigarette lighters (Table 2). Incidents in which the heat source was abandoned, unattended, or otherwise not under control occurred in both smoking-related fires and fires involving small open flame such as candles. Fires caused by someone falling asleep occurred predominantly in smoking-related fires but also in some candle fires. Electrical malfunction incidents were classified as open flame when it was reported that arcing occurred. Electrical malfunction fires classified as "other" heat source involved electrical bedding items, mostly blankets, where the mode of failure could not be determined. Fires caused by combustibles too close to a heat source predominantly involved candles or equipment such as portable heaters.

Table 1
Heat Source by Ignition Type,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Specific Heat Source	General Heat Source					
	Total	Smoking Material	Small Open Flame	Conducted Heat	Other	Unknown
Total	241	33	144	33	25	6
Unknown	3	0	0	0	0	3
Total Known	**238**	**33**	**144**	**33**	**25**	**3**
Smoking	**33**	**32**	**1**	**0**	**0**	**0**
Small Open Flame	**139**	**1**	**136**	**1**	**1**	**0**
Lighters	73	1	72	0	0	0
Matches	6	0	6	0	0	0
Candles	41	0	40	1	0	0
Other Small						
Open Flame	19	0	18	0	1	0
Equipment	**60**	**0**	**7**	**32**	**18**	**3**
Conducted Heat	21	0	2	18	1	0
Equip, Cause NS	39	0	5	14	17	3
Exposure to Room Fire	**6**	**0**	**0**	**0**	**6**	**0**

Source: Investigations conducted by the U.S. Consumer Product Safety Commission , January 2000 to June 2003

Table 2
Ignition Factor by Heat Source,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Ignition Factor	General Heat Source					
	Total	Smoking Material	Small Open Flame	Conducted Heat	Other	Unknown
Total	241	33	144	33	25	6
Unknown	7	0	2	0	1	4
Total Known	**234**	**33**	**142**	**33**	**24**	**2**
Child Play	78	1	76	1	0	0
Abandoned, Lack of Control, Unattended	45	16	23	1	5	0
Electrical Malfunction	38	0	15	3	18	2
Combustible too Close	33	0	10	22	1	0
Fell Asleep	20	16	3	1	0	0
Overturned	17	0	12	5	0	0
Other	3	0	3	0	0	0

Source: Investigations conducted by the U.S. Consumer Product Safety Commission, January 2000 to June 2003

B. Items Ignited

Determination of whether the mattress or a bedclothes item ignited first was based on the reported scenario as described in the methodology. Based on this evaluation, it was determined that a non-electric bedclothes item ignited first in 190 of 235 fires (81 percent) (Table 3). However, in 75 percent of those bedclothes ignitions it was not possible to determine the type of bedclothes involved. Among incidents for which a specific item was reported, sheets, blankets, and comforters/quilts were the items cited most frequently. Electric blankets were cited more frequently than other types of blankets but it is possible that this distribution is a function of the investigation assignment criteria used.

Table 3
Item First Ignited by Ignition Type,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Item First Ignited	Heat Source					
	Total	Smoking Material	Small Open Flame	Conducted Heat	Other	Unknown
Total	241	33	144	33	25	6
Unknown	6	1	3	0	1	1
Total Known	**235**	**32**	**141**	**33**	**24**	**5**
Mattress	**21**	**2**	**15**	**1**	**2**	**1**
Total Bedclothes	**190**	**27**	**120**	**31**	**9**	**3**
Blankets	12	0	11	1	0	0
Sheets	11	1	9	1	0	0
Comforter/Quilt	10	0	7	2	1	0
Pillow	7	1	4	2	0	0
Mattress Pad*	3	0	2	1	0	0
Bedspread	4	0	4	0	0	0
Dust Ruffle	1	1	0	0	0	0
Bedding, Not Spec.	142	24	83	24	8	3
Box Spring	**7**	**1**	**5**	**0**	**0**	**1**
Electric Blanket/Pad	**14**	**0**	**0**	**1**	**13**	**0**
Futon	**3**	**2**	**1**	**0**	**0**	**0**

*Includes one plastic mattress cover.
Source: Investigations conducted by the U.S. Consumer Product Safety Commission , January 2000 to June 2003

The investigated fires above included 25 injuries reported through the NEISS probability sample of hospital emergency room-treated injuries. Among the investigated injuries reported by NEISS hospital emergency rooms (Table 4), non-electric bedclothes items were the first item to ignite in 21 (84 percent) of the mattress and bedclothes fires, similar to the 81 percent seen among the investigated fires from all sources shown in Table 3.

Table 4
Item First Ignited in Investigated Mattress/Bedding Fires, Where Fire Injuries Were Treated in Hospital Emergency Rooms, 7/02 – 6/03

Item First Ignited	Frequency
Total	50
Unknown	25
Total Known	**25**
Mattress	**4**
Total Bedding	**21**
Blankets	3
Sheets	5
Comforter	1
Pillow	3
Mattress Pad	1
Bedspread	2
Bedding NS	4
Box Spring	**1**
Electric Blanket	**1**

Source: NEISS and CPSC investigation reports

For fires investigated since October 2002, CPSC investigators attempted to determine both the bedclothes items that were on the bed at the time of the fire and the bedclothes items that ignited in the fire. Such information was available for some earlier fires as well. Among 22 fires in which both pieces of information were available, most bedding items present ignited at some point during the fire (Table 5).

Table 5
Bedding Present and Bedding Ignited,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Bedding Type	Present	Damaged/ Involved
Total	122	105
Mattress Pad	10	9
Sheets	32	29
Blankets	26	22
Comforter/Quilt	18	14
Bedspread	8	7
Pillow	16	13
Dust Ruffle	3	3
Gel Overlay	1	1
Electric Blanket	7	6
Electric Mattress Pad	1	1

Includes only incidents in which bedding present was cited, n=22.
Most incidents cited multiple bedding items present.
Source: Investigations conducted by the U.S. Consumer Product Safety Commission , January 2000 to June 2003

When bedclothes items included filling material, CPSC attempted to identify the contents. Filling material content was reported for 29 bedding items that ignited (Table 6) and involved a variety of filling materials.

Table 6
Filling Material by Filled Bedclothes Item Ignited,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Filling Material	Filled Bedclothes Item			
	Total	Mattress Pad	Comforter	Pillow
Total Reported	29	8	11	10
Cotton/Cotton Batting	7	1	4	2
Cotton/Polyester Blend	2	0	1	1
Polyester	7	3	3	1
Down/Feather	5	0	2	3
Foam	7	4	0	3
Unknown	1	0	1	0

Source: Investigations conducted by the U.S. Consumer Product Safety Commission , January 2000 to June 2003

When mattresses were ignited, even if not the first item to ignite, CPSC investigators attempted to identify the location on the mattress that ignited first. Such information was obtained for 58 incidents; 22 mattresses were ignited on the top surface, 21 were ignited on a side surface, 13 were ignited on the underside, and 2 were ignited on the tape edge (Table 7).

Table 7
Location of Mattress Ignition by Ignition Type,
Investigated Mattress/Bedding Fires, 1/00 – 6/03

Mattress Ignition Location	Heat Source					
	Total	Smoking Material	Small Open Flame	Conducted Heat	Other	Unknown
Total Reported	**58**	**4**	**36**	**9**	**7**	**2**
Top	**22**	**4**	**12**	**3**	**3**	**0**
Smooth Top	16	3	8	3	2	0
Quilted Top	4	0	3	0	1	0
Top, NS	2	1	1	0	0	0
Side	**21**	**0**	**13**	**5**	**2**	**1**
Underside	**13**	**0**	**9**	**1**	**2**	**1**
Tape Edge	**2**	**0**	**2**	**0**	**0**	**0**

Includes incidents where the mattress was not the first item to ignite.
Source: Investigations conducted by the U.S. Consumer Product Safety Commission , January 2000 to June 2003

IV. Discussion

This report provides the most recent available data on bedclothes items involved in investigated mattress/bedding fires. Among the incidents included here, it appears that non-electric bedclothes items were the first items to ignite in about 80 percent of mattress and bedding fires. Although the distribution of heat sources involved in the investigated incidents is somewhat different than in the national estimates of fire service attended fires, it is not clear that this would be expected to affect the distribution of bedclothes either present or ignited.

Conclusions about the relative propensity of specific types of bedding items to ignite are prevented by the lack of information about the prevalence of bedding items in use generally and the lack of information about the bedding items present for most of the investigated fires.

V. Conclusion

Data reviewed for this report indicated that bedding was a major contributor to ignition in fires that ignited mattresses. In addition, the data indicated that once a fire was ignited, most bedding items that were present ignited at some point in the ensuing fire.

Appendix A
Search Criteria Used to Identify Mattress and Bedding Incidents in the CPSC Databases

Searches included the product codes listed below. In addition, searches were conducted for the words "mattress" or "bedding," and designation of a fire in the NEISS Fire Involvement Variable (codes 1, 2, or 3 – NEISS only).

Product Code	Definition
0132	Electric blankets or sheets
0667	Bedspreads, throws, or comforters
0689	Blankets, not specified
1542	Baby mattresses or pads
4002	Bedding, not specified
4009	Non-baby mattresses, excluding camp mattresses
4010	Mattresses, not specified
4050	Pillows, excluding water pillows
4051	Sheets or pillowcases
4054	Other bedding
4064	Futons
4076	Beds or bed frames, not specified

Tab I

U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

October 29, 2004

TO: Margaret Neily, Project Manager for Mattresses & Bedding
Directorate for Engineering Sciences

THROUGH: Hugh McLaurin, Associate Executive Director
Directorate for Engineering Sciences

FROM: Allyson Tenney, M.S., Textile Technologist
Directorate for Engineering Sciences

SUBJECT: Bedclothes Flammability

Introduction

Mattress and bedding fires continue to be among the biggest contributors to residential fire deaths and civilian injuries among products within the jurisdiction of the U.S. Consumer Product Safety Commission (CPSC). Based on national fire estimates for the five-year period between 1995-1999, ignition of mattresses and bedding resulted in an estimated 19,400 residential fires, 440 deaths, 2,230 injuries, and $273.9 million in property loss annually.

A significant portion of these deaths and injuries is caused by ignition from open-flame sources. The most common open-flame ignition sources in mattress and bedding fires are lighters, matches, and candles. Other small open-flame heat sources include heat escaping from fueled equipment, molten material, short circuit arcs, and heat from overloaded equipment.

Typical fire incident reports only allow an analysis of the combination of mattresses with bedclothing since both are usually involved in the same fire scenarios. In order to gain a better understanding of the contribution of bedclothes to mattress fires, CPSC staff analyzed CPSC in-depth investigations reports (IDIs) of 431 mattress and bedding fires that have been conducted since 1994. For the cases in which the first

item ignited was specified, bedclothing was the first item ignited in 146 (52%) of those cases (Hiser, 2000). Based on this analysis, staff concludes that the majority of mattress and bedding fires involves ignition of the bedclothes.

Once ignited, the bedclothes become a large ignition source to the mattress. The amplified ignition source presented by the bedclothes increases the potential for the mattress to become fully involved, posing a substantial fire threat. In addition, the energy released by the burning bedclothes, depending on their collective fuel load, contributes to the rate of fire growth and the magnitude of the fire.

Bedclothing typically includes a range of items used in combinations which vary with style, regional, and seasonal trends. Bedclothing items range from sheets and blankets (non-filled items) to pillows, quilts, mattress pads, and comforters (filled items), each one with varying compositions and characteristics. Since bedclothes present such variability, their contribution to a mattress fire and the extent of their involvement also varies. The complexity of the fire hazard complicates the analysis of bedclothes' involvement in mattress fires and the development of viable approaches for reducing the risks associated with such fires.

Several studies from multiple sources have investigated the burning behavior of bedclothes and attempted to understand their role and contribution in residential fire scenarios. This memorandum provides a summary of comments received on the October 2001 advance notice of proposed rulemaking (ANPR) to address ignitions of mattresses, an overview of the flammability research on bedclothes, which provides some information about typical fire scenarios involving bedclothes, available information on the burning behavior of bedclothes and impact of burning bedclothes involved in mattress/foundation fires, and existing standards for addressing the flammability of bedclothes.

Comments on Advance Notice of Proposed Rulemaking

CPSC staff prepared a briefing package, dated August 16, 2001, with options to address the deaths and injuries from open-flame ignition of mattresses. The package summarized staff studies and industry research on this hazard. It also evaluated several petitions received in 2000 from the Children's Coalition for Fire-Safe Mattresses (CCFSM) requesting open-flame standards for mattresses. The Commission voted in October 2001 to issue an advance notice of proposed rulemaking (ANPR) to develop a mandatory open-flame standard for mattresses. The ANPR was published in the *Federal Register* on October 11, 2001 (6FR51886) and invited comments concerning the risk of injury identified in the notice, the regulatory alternatives being considered, and other possible alternatives.

During the comment period that closed on December 10, 2001, the CPSC received written comments from businesses, associations and interested parties representing various segments of the mattress and bedding industries. A total of sixteen comments was received. Many commenters expressed opinions on the potential scope of an open-flame mattress standard. Several of the commenters urged the

Commission to limit the scope of a standard to mattresses while other commenters recommended the scope be expanded to include both mattresses and bedclothes.

In support of limiting the scope to mattresses and not regulating bedclothes, some industry members[1] identify bedding items as an uncontrolled variable. They claim that there is no way to predict the type of bedclothes that may be involved in an incident at any given time; the number and type of items used by consumers is indefinable and consumers select items based on season, fashion, and climate. In addition, they note that there is no objective method to determine if consumers would use regulated bedclothes, there is little data to suggest that regulating some selected items will have an impact on the hazard, and flammability performance should not be based on what consumers may or may not use as bedclothes. One commenter also states that most U.S. textile manufacturers already voluntarily test for small open-flame ignition of bedclothes using ASTM D1230[2], a voluntary test method, and that, the additional burden and expense of any regulation on bedclothes would be substantial and could not be justified.

Commenters in support of regulating bedclothes believe that studying the impact of burning bedclothes is appropriate and would assist in the development of better performing, safer products. They note that bedclothes contribute to the intensity and spread of the original ignition source often involved in mattress fires, and that, burning bedclothes become a significant ignition source to the mattress and impact the burning characteristics of the mattress and foundation. They further note that bedclothes alone have been shown to generate a fire large enough to pose a hazard and can alone be the cause of ignition to nearby items. The commenters state that improving the flammability of certain bedding items, such as filled items, is economically feasible. One commenter claims that mattress fires cannot be adequately addressed without also considering the flammability of bedclothes.

In addition to comments suggesting CPSC include bedclothes in the mattress rulemaking, in November 2000, the National Association of State Fire Marshals (NASFM) issued a request to the CPSC to regulate bedding items. The request was not docketed as a petition because the request did not meet the requirements set forth in CPSC regulations, 16CFR1051, to provide incident data to substantiate the need for a regulation or describe the substance of the proposed rule.

Bedclothes Flammability Research

Several ongoing research projects have been conducted to gain a more thorough understanding of the hazards and scenarios associated with open flame ignited mattress and bedding fires. Although much of the research focused on mattresses and foundations, the significant contribution of bedclothes to the hazard necessitated the inclusion of bedclothes in some studies. These studies are summarized in this

[1] Comments were received from American Textile Manufacturers Institute, Decorative Fabric Association, Home Fashion Products Association, Juvenile Product Manufacturers Association, and National Cotton Council.

[2] ASTM D1230—*Standard Test Method for Flammability of Apparel Textiles* was adapted from U.S. Consumer Product Safety Commission, 16CFR1610—*Standard for the Flammability of Clothing Textiles,* which provides methods for testing the flammability of clothing and textiles intended to be used for clothing.

memorandum. The details pertaining to the research programs are available in separate documents (Tenney, 2004; Tenney, 2001).

SPSC/NIST research on mattresses and bedclothes The Sleep Products Safety Council (SPSC) sponsored several phases of research at The National Institute of Standards and Technology (NIST) focused on mattress and bedding flammability. Phase 1 of the research program, known as *Flammability Assessment Methodology*, involved four main objectives. The objectives focused on evaluating the fire behavior of various combinations of bedclothes, characterizing the heat impact imposed on a mattress by bedclothes, developing burners to simulate typical heat impact imposed on a mattress by bedclothes, and testing the burners on different mattress designs to ensure their consistency. NIST summarized the findings of Phase 1 in a June 2000 report, NISTIR 6497, *Flammability Assessment Methodology for Mattresses*, establishing the basis for a test method and the next phase of the research program (Ohlemiller, 2000).

To meet the objectives, the study began by evaluating the burning behavior of a range of bedclothes combinations. Twelve different combinations of bedclothes sets, ranging from very light (two sheets) to heavy (two sheets, one blanket, one heavy filled comforter) were burned on an inert, twin-size mattress made of fiberglass. The peak heat release rates varied from 50kW to 200kW. The range of peak heat release rates is attributed to the collective fuel load of the individual bedclothes items. Certain bedclothes items with higher fuel loads, such as comforters, tend to contribute higher heat release rates individually, as well as in combination with other items. Of the tested combinations of bedclothes, the combinations that included a comforter generally measured peak heat release rates greater than 100kW. From the twelve tested sets, six sets were selected to represent the range of combinations. Observations of the temperature patterns using an infrared (IR) camera and measurements of local heat fluxes using a heat flux gauge were obtained and used to develop a gas burner simulating the heat impact posed by burning bedclothes. Comparison tests of the burners and actual burning bedclothes were conducted, prompting another phase of research.

Much of Phase 2 focused on estimating the hazard posed by "bed" fires (referring to the mattress, foundation, and bedclothes) in relation to bed size, and estimated the maximum fire size that would substantially reduce the fire hazard by preventing flashover. Measuring the ability of a burning mattress to involve nearby items and the threats posed by toxicity were also part of the study. The findings were summarized in an August 2002 report, NIST Technical Note 1446, *Estimating Reduced Fire Risk Resulting from an Improved Mattress Flammability Standard* (Ohlemiller, 2002).

Part of the analysis in Phase 2 included a limited assessment of bedclothes and their contribution to mattress fire hazards. Three mattress designs of varying performance, each in twin and king size, were tested using the same set of bedclothes. The set of bedclothes (similar to a set used in Phase 1) included one mattress pad, one fitted sheet, one flat sheet, one polyester fiberfill pillow (two pillows for tests on king size mattresses), one pillow case (two pillowcases for tests on king size mattresses), one acrylic blanket, and one comforter. One mattress design, shown to contribute very little

heat release rate in prior testing, when tested with bedclothes in the worst case conditions (king-size in a room environment) resulted in a peak heat release rate of 400kW. Although this scenario would not readily cause flashover, the fire is sizeable and would typically cause a layer of accumulating hot gases and smoke to thicken downward from the ceiling. The radiation from the hot gases and smoke collecting at the ceiling can significantly enhance the development of the fire, can threaten the ignition of nearby items and typically requires occupants to crawl in order to exit the room. Enhanced room effects generally begin to happen at heat release rates of about 300kW to 400kW (Ohlemiller, 2004). Since this scenario assumes no involvement from the mattress, attributing most of the heat release during these tests to the bedclothes, it suggests that addressing the flammability of bedclothes resulting in reducing their contribution to the fire would further reduce the fire risk posed by bed fires involving improved performing mattress designs (Ohlemiller, 2002).

Research on filled bedclothes Based on the information gained from Phase 1 and 2, SPSC expanded their research by adding tests of bedclothes made with filling materials, e.g., comforters, pillows, and mattress pads. Bedclothes constructed with a variety of filling and cover materials were tested to assess the effect of material changes on the flammability behavior. Two design changes, fire resistant filling materials and protective cover fabrics, were examined with respect to improving their fire performance and reducing their contribution to mattress fire scenarios.

The SPSC bedclothes research conducted at NIST focused on filled bedclothes and items with fiberfill encased in a protective cover. Specifically, the study assessed mattress pads, pillows, and comforters. The study evaluated the three items incorporating two design changes. One design change involved a replacement of the typically used polyester fiberfill with a modified, lower heat release fiber of comparable loft. The other design change involved using a barrier type of cover to protect the typically used polyester fiberfill. The study was limited in that it used a small number of samples and a limited sample of modified fillings.

The study was conducted in two parts. The first part focused on the mattress pad. Since the mattress pad generally is used in direct contact with a mattress, it is considered to be the filled item having the most potential to be in a protective position. The mattress pad incorporated the two design changes, modified fiberfill and barrier type cover. The second part of the study incorporated the two design changes in the pillow and comforter to examine the effects of changes in all three components at once.

To examine the effects of the design changes, three different mattress and foundation designs were used. One mattress and foundation set represented a current residential mattress construction. The other two sets were experimental, improved designs. One set made using flame-retardant materials while the other set used barrier type tickings. The three selected mattress and foundation designs were used in previously conducted tests (*NISTIR 6497*). All tests used the same collection of bedding items: one pillow, one flat sheet, one fitted sheet, one pillowcase, one blanket and one comforter. Changes in heat release rate behavior, including peak rate of heat release and the time to peak, were recorded during each test.

The primary objective of the bedclothes study was to obtain a preliminary understanding of how the overall heat release rate behavior of a bedding system might be affected as a result of making reasonable design changes to bedclothes. Prior research suggests that the overall heat release rate of a bedding system, meaning the mattress, foundation, and bedclothes, might reach a level comparable to that of the bedclothes alone as the performance of the mattress improves. The peak rate of heat release for some bedclothes combinations alone can pose a significant threat of flashover or near flashover room conditions. It is therefore suggested that further reduction of the hazard might be dependent on lessening the contribution from the bedclothes. It is also reasonable to consider that changes to the bedclothes' burning behavior may also slow the rate of burning of the overall bed system. It appears that the fire performance of the mattress and foundation depends on the extent and duration of their ignition source, which is typically bedclothes.

A report on the bedclothes study and related hazards was published in February 2003, NIST Technical Note 1449, *Effect of Bedclothes Modifications on Fire Performance of Bed Assemblies*. According to NIST's report, for a standard to be most effective, the performance of the entire bedding system (mattress, foundation, and bedclothes) must be taken into consideration. It was shown that the bedclothes and the mattress and foundation function as a system and that the effectiveness of bedding design changes depends on the mattress design. Protecting the mattress sides, either by design or improved bedclothes, resulted in a major improvement in the flammability of the bedding system, indicated by a decreased peak rate of heat release or an increase in time to peak. Improved pillows decrease the flammability of the system since unimproved pillows tend to burn for a long time. Improved mattress designs with reduced peak heat release rates have less potential synergism with bedclothes. This is because the early peak rate of heat release is caused by the flammability behavior of the bedclothes, and the bedclothes have burned away before any late peak heat release rate occurs from the mattress (Ohlemiller, 2003).

A related research project contracted by CPSC at NIST, reinforced one of the conclusions of the bedclothes study. Although the project was focused on mattress flammability, a portion of the tests was conducted using conventional bedclothes instead of the burners that simulate burning bedclothes. Tests on improved mattress designs with burning bedclothes as the ignition source tended to exhibit a bed fire with two well-separated heat release rate peaks. The first peak is predominately from the burning bedclothes while the second is predominately the mattress and foundation. NIST found the second peak to be comparable to or lower than the first peak and to occur appreciably later in tests of good performing mattress designs (Ohlemiller, 2003). This means that while the mattress is contributing very little, the bedclothes are creating a sizeable fire on their own, up to 800kW for certain combinations (Ohlemiller, 2004).

A more recent study on mattress flammability conducted by NIST under contract with CPSC, included a series of tests using the same bedclothes combination on twin, queen, and king size mattresses. The tests were conducted in a room environment to evaluate any resulting room effects, which generally start to happen at heat release rates of about 300kW to 400kW. The early heat release rate peaks, driven primarily by burning bedclothes, were shown to triple from twin size to king size. Larger size

bedclothes combinations on well performing mattress designs (less than 50kW when tested with burners and no bedclothes) showed heat release rate peaks up to 800kW, occurring 7-8 minutes after ignition. On mattress designs that yield a moderate heat release rate peak with burners, the bedclothes resulted in more serious fires. The study shows that a combination of some bedclothes and a well performing mattress and foundation are sufficient to cause flashover of the room (Ohlemiller, 2004). These findings were the basis for the estimated effectiveness of the draft proposed standard for mattress flammability. The basis for estimating effectiveness is available in a separate memorandum (Smith & Miller, 2004).

The available NIST data shows that bedclothes tend to burn in a similar pattern, despite the range of observed heat release rate peaks among different bedclothes combinations. After ignition, the first few minutes are generally characterized by slow burning and very low heat release. Typically, the peak occurs between 5 and 10 minutes after ignition. The fire intensity recedes as the fuel from the bedclothes is consumed, usually a few minutes after the peak (Ohlemiller, 2004).

State of California

Additional information on the flammability of bedclothes was obtained by tests conducted by the California Bureau of Home Furnishings (CBHF). The California state legislature passed Assembly Bill 603 (AB 603) mandating that the CBHF issue a standard for mattresses/bedding flammability. The CBHF is also authorized to investigate and regulate the flammability of filled bedclothes (items that have a filling encased in a cover, like pillows, comforters, quilts, and mattress pads). In cooperation with a group of industry representatives, CBHF conducted a series of bedclothes tests to obtain flammability data to assist in the rulemaking procedure. CBHF attempted to develop a small scale test that will predict the flammability behavior of filled bedclothes.

With industry support, CBHF conducted a series of tests using a variety of bedclothing combinations. The exploratory series of tests evaluated the flammability of comforters, mattress pads and pillows using various filling materials. The filling materials used included conventional batting, three different improved synthetic battings, cotton fiber blend batting, and feather and down fill. Some tests added a blanket. All tests were conducted using sheets and a pillowcase. The bedding materials were evaluated on an inert mattress, made from a material that could resist the imposed fire threat with no energy contribution.

Preliminary test results suggested several findings consistent with the research conducted at NIST. Results showed mattresses and bedclothing function as a system with the bedclothing being a contributor to the hazard. Improved fillings, those with flame resistant properties, show better fire performance when compared to conventional fillings. In some cases, improved bedclothes offer additional protection to an improved mattress.

CBHF intends to use the findings obtained from full-scale testing of bedclothes for developing a small-scale test that will predict the flammability behavior of filled bedclothing. To assist CBHF in the test development, a group of industry

representatives organized a task force. The purposes of the task force were to share existing test information and participate in obtaining test data. Based on limited information available at the time, CBHF drafted Technical Bulletin 604 (TB 604), *Test Procedure and Apparatus for the Flame Resistance of Filled Bedclothing,* for industry review in May 2003. The draft technical bulletin outlined a small scale test procedure for filled bedding items. The test criteria are to be determined. Concerns regarding the point of ignition, durability procedures, standard sheeting, and post tests for strength have been raised by industry members. As a result of the numerous concerns raised, the group of industry representatives re-organized and revised the testing program. A working meeting of the task force is scheduled in late autumn, 2004 to review the updated draft technical bulletin. CBHF plans to issue a proposed rule on bedclothing late in 2004.

Existing Standards

Currently, there are no mandatory flammability requirements for residential bedclothes or bedding items in the United States. There are a limited number of voluntary standards that pertain to bedding items. ASTM International has a published standard test method for blanket flammability, ASTM D4151-92(2001). The standard provides a test method for identifying blanket fabrics which ignite easily and propagate flame across their surface. Underwriters Laboratories (UL) has a standard for electric blankets.

The International Organization for Standardization (ISO) has a standard, divided into four parts, for the burning behavior of bedding items. ISO standards are voluntary and developed by representatives from 146 countries. International Standard ISO 12952—*Textiles—Burning behaviour of bedding items, Parts 1-4*, specifies a general test method for assessing the comparative ignitability of any and all bedding items. The test method specifies that the bedding specimen be placed on the actual mattress, if known, or on a specified test rig consisting of a platform of open mesh. The specimen is ignited by a propane gas flame of 200mm in length (the flame height is approximately 35mm) for 15 seconds. The presence of any progressive smoldering and/or flaming is noted and timed. The test is stopped after 60 minutes. The test relates only to the comparative ignitability of the tested materials under the specific conditions of the test. The test is not intended as a means for assessing the potential fire hazard presented by the bedding item or the contribution of bedclothes to a residential mattress and bedding fire.

It does not appear that any of the reviewed standards would be adequate for addressing the specific hazard posed by burning bedclothes as they relate to the hazard of open-flame residential mattress and bedding fires.

Conclusion

The flammability hazards from open-flame ignition of bedclothes depend on the likelihood of ignition, the burning intensity and rate of growth of the resulting fire, the fire's potential to ignite nearby combustibles, and the possibility of reaching conditions capable of causing flashover. Recent flammability research programs have provided a

better understanding of residential mattress and bedclothes fire scenarios and supporting data on mattress and bedclothes flammability behavior. The data clearly show that a relationship exists between the mattress and bedclothes and that both work together as a system.

Although mattresses and bedclothes work together as a system, it is useful to consider their flammability separately. Available test data show that certain bedclothes combinations and possibly individual items produce sizeable fires on their own. In some cases, these fires present a risk of flashover. This suggests that certain bedclothes items, particularly those with high fuel loads, could be identified.

Limited data on the flammability of bedclothes tested alone suggest that filled bedding items contribute to the fire hazard and have the potential to be modified to improve performance. Since the mattress and bedclothes work as a system, it appears that as the performance of mattresses improves, the performance of the bedclothes becomes more distinct and separate from the contribution of the mattress. As more research is conducted on bedclothes flammability, an increasing emphasis is being placed on the need for reducing the contribution of filled bedding items (mattress pads, pillows, and comforters). The extent to which bedclothes can be modified in ways that are technologically reasonable and economically feasible is unclear at this time.

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Tab J

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 5, 2004

TO : Margaret L. Neily, ESFS

THROUGH: Gregory B. Rodgers, Ph.D., AED, EC GBR

FROM : Terrance R. Karels, EC TRK

SUBJECT : Bedding Market Information

The staff is providing the Commission with information so that it can consider whether to issue an Advance Notice of Proposed Rulemaking (ANPR) to develop a possible flammability standard for certain bedding products. This memorandum presents some preliminary product and market information for filled bedding products, including the results of a 2003 survey conducted by the American Textiles Manufacturers Institute (ATMI) on the US market for filled textile bedding products. The ATMI conducted the survey of its members at the request of California's Bureau of Home Furnishings and Thermal Insulation in order to develop market information on these products. California is considering a regulation for filled bedding (TB 604) in conjunction with its regulation for mattresses (TB 603).

FILLED BEDDING PRODUCTS

ATMI Survey

ATMI informally surveyed 12 firms that market filled textile bedding products, including mattress pads, comforters, quilts, bedspreads, and pillows. These firms reportedly account for about 80% of the US market for these products. ATMI then estimated the remainder of the market. The result is an estimate of the total 2002 US market for these products. According to ATMI, overall textile industry sales have been trending downward in recent years.

While the 12 surveyed firms are identified as "US manufacturers," it should be noted that "outsourcing" has become increasingly common with these products. A sizeable portion of filled bedding for the US market is being produced outside the US; thus, the term "production" in the table below refers to both US-made and foreign-made filled bedding destined for the US market. Trade sources indicate that imports of filled bedding products are up moderately in recent years. Import statistics for 2002, compiled by the US Department of Commerce, revealed that perhaps 90% of all "quilts and comforters" (a single trade category) were imported, and perhaps 20% of bed pillows were imported. The trade analyst for these products at the US International Trade Commission stated that, since shipment costs are based on volume rather than weight or value, it is more expensive to ship/import pillows, as compared to quilts. Based on the survey, ATMI estimated sales, as follows:

Filled Bedding Products	2002 Production (Millions of Units)
Mattress Pads	17.9
Comforters	27.6
Bed Pillows	84.8
Quilts	0.6
Bedspreads[1]	0.6
Decorative Pillows	7.5

Source: ATMI survey, 2003

The most common fill material for this bedding was reported to be polyester, which ranged from a low of 57% of the fill used for quilts, to 100% of the fill used for bedspreads. Of the larger categories of filled bedding, some 96% of mattress pads, 86% of comforters, and 89% of bed pillows used polyester.

[1] Includes only bedspreads that incorporate a filler.

The survey also revealed that the most common size of bedding products is queen. Some 35% of mattress pads and 32% of quilts produced were for queen-size beds. Comforters are commonly sold in a combined full/queen size; 50% of comforters produced would fall within the full/queen category.

Information from the Trade Press

In its 2003 annual business issue, **Home Textiles Today** (a trade publication) reported that the top 5 firms marketing comforters and bedspreads (Springs Industries, Westpoint Stevens, Dan River, Croscill Home, and Pillowtex) sold about $1.1 billion worth of products in the US in 2002, essentially unchanged from 2001. Trade sources reported that, although overall industry sales decreased in 2001, sales have rebounded slightly in 2002. Down comforters (a different category) experienced a 10% increase in sales over the period, to $303 million in 2002. The top 5 marketers of down comforters were Pacific Coast Feather, Pillowtex, Hollander Home Fashions, Down Lite International, and Phoenix Down. Similarly, sales of sleep pillows by the top 5 marketers (Pillowtex, Pacific Coast, Hollander, Springs, and Westpoint Stevens) rose by 9% over the period, to $582 million in 2002. The top 5 producers of mattress pads (Louisville Bedding, Pillowtex, Perfect Fit Industries, Pacific Coast, and Springs) saw sales increase by 12%, to $303 million in 2002. It should be noted that Pillowtex went out of business in 2003.

Home Textiles Today also reported that 40% of all bedding sales in 2001 (the latest year for which information is available) were through discount stores; home specialty chains were the next-largest retailers of these products, with 21% of total sales. These sales figures also include sheets, which are not subject to California's potential regulation.

OTHER BEDDING PRODUCTS

While not considered filled bedding products, all-foam mattress pads are constructed of the same types of foam used in filled bedding products. Thus, mattress pads also may have an impact on the flammability of other bedding products and mattresses.

Foam mattress pads may be a flat surface or may be in an "egg crate" design. Another distinction in mattress pads is "memory foam" pads. The memory foam pads contour to the body's shape, rather than acting as a resistance to body weight (as in other foam pads). Memory pads are advertised as an offshoot of technology developed for NASA's space program. While conventional mattress pads are used predominately as an inexpensive protective surface over the more expensive mattress, both the egg crate and memory foam pads are touted as improving the users' sleep. Memory foam pads are enclosed in a fabric shield (or "bag"). Other foam pads most often do not incorporate a woven cover or shield.

Egg crate pads typically retail for $10 to $50 each, depending upon the size of the mattress for which they are intended. Industry sources project that perhaps 4 to 5 million egg crate pads are sold annually. Memory pads, which retail for $100 or more, were introduced about 5 years ago; they now experience sales of perhaps 3 million units a year.

CALIFORNIA TASK FORCE

The State of California held a meeting of its Bedclothing Task Force on July 1, 2003. The meeting, attended by the major manufacturers of bedclothing, trade groups, and other interested parties, was held to review that State's draft rulemaking language for its bedclothing test standard. The preliminary draft standard was represented as performance-based rather than design-based, and would include protocols for pass/fail testing. However, California is still developing the test methods and acceptance criteria for this standard.

California officials showed testing videos of various combinations of comforters, pillows, mattress pads, and blankets incorporating fire retardant (FR) materials. The fill materials were described as "better" and "improved." Manufacturers were asked about the potential costs of complying with the California draft regulation, but the manufacturers in attendance replied that, until a compliance baseline is established, it is impossible to estimate the potential costs of compliance. These manufacturers discussed the possibility of the increased costs of materials, additional labor costs due to the difficulty in sewing layers of FR materials into the bedclothes,

and the possibility that some production equipment may be made obsolete as a result of the draft requirements. Until the draft standard test criteria are established, it is not possible to gauge the extent of increased costs that may be associated with the California standard, nor is it possible to estimate the potential benefits that may be derived from the standard.

A possible CPSC flammability standard for filled bedding could result in a number of different compliance methods. These include the use of FR cover materials, FR barriers, or the use of FR fill materials. Survey participants questioned whether the availability of flame retardant fill materials would be sufficient to supply the needs of filled bedding manufacturers, at least in the short-run.

Based on the industry comments, imparting FR characteristics to polyester fill would likely require changing the polymers used to produce the polyester or weaving of other FR fibers with the polyester; this may have significant price ramifications for bedding manufacturers. Industry sources indicate that polyester fiber currently is about $.60 per pound, while alternative FR batting costs $5-8 per pound. The National Cotton Council estimated that a requirement for FR fillers may increase the final price of the polyester component of filled bedding by 4 to 5 times. A major producer of mattress pads suggested that the retail price of its pads will increase by about $10, an increase of about 40%. ATMI estimated that, for pillows, a FR shell fabric will be necessary to pass a flammability test; that group estimated a total price increase of 5 times or more at retail, but provided no supporting data. We will investigate potential costs and other economic effects as the staff develops possible tests and identifies possible product modifications.

Tab K

DRAFT OF 10/29/04

PART 1633—STANDARD FOR THE FLAMMABILITY (OPEN-FLAME) OF MATTRESSES and MATTRESS AND FOUNDATION SETS

Subpart A — The Standard

Sec.

Subpart B — Rules and Regulations

Subpart C - Interpretations and Policies

Appendix B to Part 1633 - Burner Operation Sequence

Authority: 15 U.S.C. 1193

Subpart A—The Standard

§ 1633.1 Purpose, scope, and applicability.

(a) *Purpose.* This Part 1633 establishes flammability requirements that all mattress and mattress and foundation sets must meet before sale or introduction into commerce. The purpose of the standard is to reduce deaths and injuries associated with mattress fires by limiting the size of the fire generated by a mattress or mattress and foundation set during a thirty minute test.

(b) *Scope.* (1) All mattresses and all mattress and foundation sets, as defined in § 1633.2(a) and § 1633.2(b), of any size, manufactured or imported after the effective date of this standard are subject to the requirements of the standard.

(2) One-of-a-kind mattresses and foundations may be exempted from testing under this standard in accordance with § 1633.13(c).

(c) *Applicability.* The requirements of this part 1633 shall apply to each "manufacturer" (as that term is defined in §

1633.2(i)) of mattresses and/or mattress and foundation sets which are manufactured for sale in commerce.

§ 1633.2 Definitions.

In addition to the definitions given in section 2 of the Flammable Fabrics Act as amended (15 U.S.C. 1191), the following definitions apply for purposes of this Part 1633.

(a) *Mattress* means a resilient material or combination of materials enclosed by a ticking (used alone or in combination with other products) intended or promoted for sleeping upon.

(1) This term includes, but is not limited to, adult mattresses, youth mattresses, crib mattresses (including portable crib mattresses), bunk bed mattresses, futons, flip chairs without a permanent back or arms, sleeper chairs, and water beds or air mattresses if they contain upholstery material between the ticking and the mattress core. Mattresses used in or as part of upholstered furniture are also included; examples are convertible sofa bed mattresses, corner group mattresses, day bed mattresses, roll-away bed mattresses, high risers, and trundle bed mattresses. See § 1633.9 Glossary of terms, for definitions of these items.

(2) This term excludes mattress pads, mattress toppers (items with resilient filling, with or without ticking, intended

to be used with or on top of a mattress), sleeping bags, pillows, liquid and gaseous filled tickings, such as water beds and air mattresses that contain no upholstery material between the ticking and the mattress core, upholstered furniture which does not contain a mattress, and juvenile product pads such as car bed pads, carriage pads, basket pads, infant carrier and lounge pads, dressing table pads, stroller pads, crib bumpers, and playpen pads. See § 1633.9 Glossary of terms, for definitions of these items.

(b) *Foundation* means a ticking covered structure used to support a mattress or sleep surface. The structure may include constructed frames, foam, box springs, or other materials, used alone or in combination.

(c) *Ticking* means the outermost layer of fabric or related material of a mattress or foundation. It does not include any other layers of fabric or related materials quilted together with, or otherwise attached to, the outermost layer of fabric or related material.

(d) *Upholstery material* means all material, either loose or attached, between the mattress ticking and the core of a mattress, if a core is present.

(e) *Edge seam* means the seam or border edge of a mattress or foundation that joins the top and/or bottom with the side panels.

(f) *Tape edge* means an edge seam made by using binding tape to encase and finish raw edges.

(g) *Binding tape* means a fabric strip used in the construction of some edge seams.

(h) *Seam thread* means the thread used to form stitches in construction features, seams, and tape edges.

(i) *Manufacturer* means an individual plant or factory at which mattresses and/or mattress and foundation sets are manufactured or assembled. For purposes of this Part 1633, an importer is considered a manufacturer.

(j) *Prototype* means a specific design of mattress and corresponding foundation, if any, which, except as permitted by § 1633.4(b) of this part 1633, is the same in all material respects as, and serves as a model for, production units intended to be introduced into commerce.

(k) *Prototype pooling* means a cooperative arrangement whereby one or more manufacturers may rely on a prototype produced by a different manufacturer.

(l) *Production lot* means any quantity of finished mattresses or mattress and foundation sets that are produced in a production interval defined by the manufacturer, and are intended to replicate a specific prototype that complies with this part 1633.

(m) *Confirmation Test* means a pre-market test conducted by a manufacturer that is relying on a pooled prototype produced by another manufacturer. A confirmation test must be conducted in accordance with the procedures set forth in § 1633.7 to confirm that the manufacturer can produce a mattress and corresponding foundation, if any, that is identical to the prototype in all material respects.

(n) *Specimen* means a mattress and corresponding foundation, if any, tested under ±this regulation.

(o) *Twin size* means any mattress with the dimensions 38 inches (in) (96.5 centimeters (cm)) x 74.5 in. (189.2 cm), all dimensions may vary by ± ½ in. (± 1.3 cm)

(p) *Qualified prototype* means a prototype that has been tested in accordance with § 1633.4(a) and meets the criteria stated in § 1633.3(b).

(q) *Core* means the main support system that may be present in a mattress, such as springs, foam, water bladder, air bladder, or resilient filling.

§ 1633.3 General requirements.

(a) *Summary of test method.* The test method set forth in § 1633.7 measures the flammability (fire test response characteristics) of a mattress specimen by exposing the specimen to a specified flaming ignition source and allowing it to burn freely under well-ventilated, controlled environmental conditions. The flaming ignition source shall be a pair of propane burners. These burners impose differing fluxes for differing times on the top and sides of the specimen. During and after this exposure, measurements shall be made of the time-dependent heat release rate from the specimen, quantifying the energy generated by the fire. The rate of heat release must be measured by means of oxygen consumption calorimetry.

(b) *Test criteria.* When testing the mattress or mattress and foundation set in accordance with the test procedure set forth in § 1633.7, the specimen shall comply with both of the following criteria: (1) the peak rate of heat release shall not exceed 200 kilowatts ("kW") at any time within the 30 minute test; and (2) the total heat release shall not exceed 15

megajoules ("MJ") for the first 10 minutes of the test. In the interest of safety, the test operator should discontinue the test and record a failure if a fire develops to such a size as to require suppression for the safety of the facility.

(c) *Testing of mattress and corresponding foundation.* Mattresses to be offered for sale with a foundation shall be tested with that foundation. Mattresses to be offered for sale without a foundation shall be tested alone.

(d) *Compliance with this standard.* Each mattress or mattress and foundation set sold or introduced into commerce after _____ [effective date] shall meet the test criteria specified in paragraph (b) of this section and otherwise comply with all applicable requirements of this part 1633.

§ 1633.4 Prototype testing requirements.

(a) Except as otherwise provided in paragraph (b) of this section, each manufacturer shall cause three specimens of each prototype to be tested according to § 1633.7 and obtain passing test results according to § 1633.3(b) before selling or introducing into commerce any mattress or mattress and foundation set based on that prototype, unless the manufacturer complies with the prototype pooling and confirmation testing requirements in § 1633.5.

(b) Notwithstanding the requirements of paragraph (a) of this section, a manufacturer may sell or introduce into commerce a mattress or mattress and foundation set based on a prototype that has not been tested according to § 1633.3(b) if that prototype differs from a qualified prototype only with respect to: (1) mattress/foundation size (e.g., twin, queen, king); (2) ticking, unless the ticking of the qualified prototype has characteristics (such as chemical treatment or special fiber composition) designed to improve performance on the test prescribed in this part; and/or (3) the manufacturer can demonstrate, on an objectively reasonable basis, that a change in any component, material, or method of construction will not cause the prototype to exceed the test criteria specified in § 1633.3(b).

(c) All tests must be conducted on specimens that are no smaller than a twin size, unless the largest size mattress or mattress and foundation set produced is smaller than a twin size, in which case the largest size must be tested.

(d) (1) If each of the three specimens meets both the criteria specified in § 1633.3(b), the prototype shall be qualified. If any one (1) specimen fails to meet the test criteria of § 1633.3(b), the prototype is not qualified.

(2) Any manufacturer may produce mattresses and foundations, if any, for sale in reliance on prototype tests performed before the effective date of this Standard, provided that such tests were conducted in accordance with all requirements of this section and § 1633.7 and yielded passing results according to the test criteria of § 1633.3(b).

§ 1633.5 Prototype pooling and confirmation testing requirements.

(a) *Prototype pooling.* One or more manufacturers may rely on a prototype produced by another manufacturer provided that:

(1) The prototype meets the requirements of § 1633.4; and

(2) The mattresses or mattress and foundation sets being produced based on the prototype have components, materials, and methods of construction that are identical in all material respects to the prototype except as otherwise permitted by § 1633.4(b) of this part 1633.

(b) *Confirmation testing.* Any manufacturer ("Manufacturer B") producing mattresses or mattress and foundation sets in reliance on a prototype produced by another manufacturer ("Manufacturer A") shall cause to be tested in accordance with § 1633.7 at least one (1) specimen produced by Manufacturer B of each prototype of Manufacturer A upon which said Manufacturer B

is relying. The tested specimen must meet the criteria under § 1633.3(b) before Manufacturer B may sell or introduce any mattresses or mattress and foundation sets based on the pooled prototype.

(c) *Confirmation test failure.* (1) If the confirmation test specimen fails to meet the criteria of § 1633.3(b), the manufacturer thereof shall not sell any mattress or mattress and foundation set based on the same prototype until that manufacturer takes corrective measures, tests a new specimen, and the new specimen meets the criteria of § 1633.3(b).

(2) If a confirmation test specimen fails to meet the criteria of § 1633.3(b), the manufacturer thereof must notify the manufacturer of the prototype of the test failure.

§ 1633.6 Quality Assurance Requirements.

(a) Quality assurance. Each manufacturer shall implement a quality assurance program to ensure that mattresses and mattress and foundation sets manufactured for sale are identical in all material respects to the prototype on which they are based. At a minimum these procedures shall include:

(1) Controls, including incoming inspection procedures, of all mattress and mattress and foundation set components and

materials to ensure that they are identical in all material respects to those used in the prototype;

(2) Designation of a production lot that is represented by the prototype; and

(3) Inspection of mattresses and mattress and foundation sets produced for sale sufficient to demonstrate that they are identical to the prototype in all material respects.

(b) *Production Testing.* Manufacturers are encouraged to conduct, as part of the quality assurance program, random testing of mattresses and mattress and foundation sets being produced for sale according to the requirements of §§ 1633.3 and 1633.7.

(c) *Failure of mattresses produced for sale to meet flammability standard.*

(1) Sale of mattresses and foundations. If any test performed for quality assurance yields results which indicate that any mattress or mattress and foundation set of a production lot does not meet the criteria of § 1633.3(b), or if a manufacturer obtains test results or other evidence that a component or material or construction/assembly process used could negatively affect the test performance of the mattress as set forth in § 1633.3(b), the manufacturer shall cease

production and distribution in commerce of such mattresses and/or mattress and foundation sets until corrective action is taken.

(2) Corrective actions. A manufacturer must take corrective action when any mattress or mattress and foundation set it manufactured or imported for sale fails to meet the flammability test criteria set forth in § 1633.3(b).

§ 1633.7 Mattress Test Procedure.

(a) Apparatus and Test Materials (1) *Calorimetry.* The rate of heat release must be measured by means of oxygen consumption calorimetry. The calibration should follow generally accepted practices for calibration. The calorimetry system shall be calibrated at a minimum of two (2) calibration points, at 75 kW and 200 kW.

(2) *Testroom.* The testroom must have either Test Configuration A or B.

(i) *Test Configuration* A. (an open *calorimeter (or furniture calorimeter)).* In this configuration, the specimen to be tested is placed under the center of an open furniture calorimeter. Figure 1 shows the test assembly atop a bedframe and catch surface. The specimen shall be placed under an open hood which captures the entire smoke plume and is instrumented

for heat release rate measurements. The area surrounding the test specimen in an open calorimeter layout shall be sufficiently large that there are no heat re-radiation effects from any nearby materials or objects. The air flow to the test specimen should be symmetrical from all sides. The air flow to the calorimeter hood shall be sufficient to ensure that the entire fire plume is captured, even at peak burning. Skirts may be placed on the hood periphery to help assure this plume capture, if necessary, though they must not be of such an excessive length as to cause the incoming flow to disturb the burning process. Skirts must also not heat up to the point that they contribute significant re-radiation to the test specimen. The air supply to the hood shall be sufficient that the fire is not in any way limited or affected by the available air supply. The fire plume should not enter the hood exhaust duct. Brief (seconds) flickers of flame that occupy only a minor fraction of the hood exhaust duct inlet cross-section are not a problem since they do not signify appreciable suppression of flames.

(ii) *Test Configuration B.* The test room shall have dimensions 3.05 meters (m) ± 25 millimeters (mm) by 3.66 m ± 25 mm by 2.44 m ± 25 mm (10 feet (ft) by 12 ft by 8 ft) high. The specimen is placed within the burn room. All smoke exiting from

the room is caught by a hood system instrumented for heat release rate measurements. The room shall have no openings permitting air infiltration other than a doorway opening 0.97 m ± 6.4 mm by 2.03 m ± 6.4 mm (38 in by 80 in) located as indicated in Fig. 2 and other small openings as necessary to make measurements. Construct the test room of wood or metal studs and line it with fire-rated wallboard or calcium silicate board. Position an exhaust hood outside of the doorway so as to collect all of the combustion gases. There shall be no obstructions in the air supply to the set-up.

(2) *Location of test specimen.* The location of the test specimen is shown in Fig. 2. The angled placement is intended to minimize the interaction of flames on the side surfaces of the test specimen with the room walls. One corner of the test specimen shall be 13 centimeters (cm) to 17 cm from the wall and the other corner shall be 25 cm to 30 cm from the wall. The test room shall contain no other furnishings or combustible materials except for the test specimen.

(3) *Bed frame.* For twin size mattresses, the specimen shall be placed on top of a welded bed frame (1.90 m by 0.99 m by 115 mm high; 75 in by 39 in by 4.5 in high) made from 38 mm (1.5 in) steel angle. The frame shall be completely open under

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the foundation except for two crosspieces, 25 mm wide (1 in) at the 1/3 length points. If testing a size other than twin, the relationship of the mattress to the frame shall be comparable to that specified in this paragraph.

(4) *Catch pan.* The bed frame feet shall rest on a surface of either calcium silicate board or fiber cement board, 13 mm (0.5 in) thick, 2.11 m by 1.19 m (83 in by 47 in). The board serves as a catch surface for any flaming melt/drip material falling from the bed assembly and may be the location of a pool fire that consumes such materials. This surface must be cleaned between tests to avoid build-up of combustible residues. Lining this surface with aluminum foil to facilitate cleaning is not recommended since this might increase fire intensity via reflected radiation.

(5) *Ignition Source.* (i) *General.* The ignition source shall consist of two T-shaped burners as shown in Fig. 3 and 4. One burner impinges flames on the top surface of the mattress. The second burner impinges flames on the side of the mattress and on the side of the foundation. Each of the burners shall be constructed from stainless steel tubing (12.7 mm diameter with 0.89 ± 0.5 mm wall thickness; 0.50 in diameter with 0.035 ± 0.002 in wall). Each burner shall incorporate a stand-off foot to set

its distance from the test specimen surface (Fig. 5). Both burners shall be mounted with a mechanical pivot point but the side burner is locked in place to prevent movement about this pivot in normal usage. The top burner, however, is free to rotate about its pivot during a burner exposure and is lightly weighted so as to exert a downward force on the mattress top through its stand-off foot so that the burner follows a receding top surface on the test specimen (Fig. 6). The combination of burner stand-off distance and propane gas flow rate to the burners determines the heat flux they impose on the surface of the test specimen so that both of these parameters are tightly controlled.

(ii) *Top surface burner.* The T head of the top surface burner (horizontal burner, Fig. 3) shall be 305 ± 2 mm (12 ± 0.08 in) long with gas tight plugs in each end. Each side of the T shall contain 17 holes equally spaced over a 135 mm length (8.5 mm ± 0.1 mm apart; 0.333 ± 0.005 in). The holes on each side shall begin 8.5 mm (0.33 in) from the centerline of the burner head. The holes shall be drilled with a #56 drill and are to be 1.17 mm to 1.22 mm (0.046 in to 0.048 in) in diameter. The holes shall be pointed 5° out of the plane of the Figure. This

broadens the width of the heat flux profile imposed on the surface of the test specimen.

(iii) *Side surface burner.* The T head of the side surface burner (vertical burner) shall be constructed similarly to the top surface burner, as shown in Fig. 4, except that its overall length shall be 254 ± 2 mm (10 ± 0.08 in). Each side of the burner head shall contain 14 holes spaced evenly over a 110 mm length (8.5 mm ± 0.1 mm apart; 0.333 ± 0.005 in). The holes shall be drilled with a #56 drill and are to be 1.17 mm to 1.22 mm (0.046 in to 0.048 in) in diameter. The holes shall be pointed 5° out of the plane of the Figure.

(iv) *Burner stand-off.* The burner stand-off on each burner shall consist of a collar fixed by a set screw onto the inlet tube of the burner head (Fig. 5). The collar shall hold a 3 mm diameter stainless steel rod having a 12.7 mm by 51 mm by (2 - 2.5 mm) thick (0.5 in by 2 in by (0.08 - 0.10) in thick) stainless steel pad welded on its end with its face (and long axis) parallel to the T head of the burner. The foot pad shall be displaced about 10 mm to 12 mm from the longitudinal centerline of the burner head so that it does not rest on the test specimen in an area of peak heat flux. A short section (9.5 mm outer diameter ("OD"), about 80 mm long; 3/8 in OD,

about 3.2 in long) of copper tubing shall be placed in the inlet gas line just before the burner to facilitate making the burner nominally parallel to the test specimen surface (by a procedure described below). The copper tube on the top surface burner must be protected from excessive heat and surface oxidation by wrapping it with a suitable layer of high temperature insulation. Both copper tubes are to be bent by hand in the burner alignment process. They must be replaced if they become work-hardened or crimped in any way.

The gas inlet lines (12.7 mm OD stainless steel tubing; 0.50 in) serve as arms leading back to the pivot points and beyond, as shown in Fig. 6. The length to the pivot for the top burner shall be approximately 1000 mm (40 in).

(v) *Frame*. Figure 6 shows the frame that holds the burners and their pivots, which are adjustable vertically in height. All adjustments (burner height, burner arm length from the pivot point, counterweight positions along the burner arm) are facilitated by the use of knobs or thumbscrews as the set screws. The three point footprint of the burner frame, with the two forward points on wheels, facilitates burner movement and burner stability when stationary.

(vi) *Arms.* The metal arms attached to the burners shall be attached to a separate gas control console by flexible, reinforced plastic tubing.[1] The gas control console is mounted separately so as to facilitate its safe placement outside of the test room throughout the test procedure. The propane gas lines running between the console and the burner assembly must be anchored on the assembly before running to the burner inlet arms. A 1.5 m ± 25 mm (58 in ± 1 in) length of flexible, reinforced tubing between the anchor point and the end of each burner inlet allows free movement of the top burner about its pivot point. The top burner arm shall have a pair of moveable cylindrical counterweights that are used, as described below, to adjust the downward force on the stand-off foot.

(vii) *Burner head.* Each burner head shall have a separate pilot light consisting of a 3 mm OD (1/8 in OD) copper tube with an independently-controlled supply of propane gas. The tube terminates within 10 mm of the center of the burner head. Care must be taken to set the pilot flame size small enough so as not to heat the test specimen before the timed burner exposure is begun.

[1] Fiber-reinforced plastic tubing (6 mm ID by 9.5 mm OD; ¼ inch ID by ¾ inch OD) made of PVC should be used.

(viii) *Flow control system.* Each burner shall have a flow control system of the type shown in Fig. 7. Propane gas from a source such as a bottle is reduced in pressure to approximately 70 kilopascals ("kPa") (20 pounds per square inch gage ("psig")) and fed to the system shown in Fig. 8. The gas flow to the burner is delivered in a square-wave manner (constant flow with rapid onset and termination) by means of the solenoid valve upstream of the flowmeter. An interval timer (accurate to ± 0.2 s) determines the burner flame duration. The pilot light assures that the burner will ignite when the solenoid valve opens[2]. The gas flow shall be set using a rotameter type of flowmeter, with a 150 mm scale, calibrated for propane. When calibrating the flowmeter, take into account that the flow resistance of the burner holes causes a finite pressure increase in the flowmeter above ambient. (If a calibration at one atmosphere is provided by the manufacturer, the flowmeter reading, at the internal pressure existing in the meter, required to get the flow rates listed below must be corrected, typically by the square root of the absolute pressure ratio. This calls for measuring the actual pressure in the flow meters

[2] If the side burner, or more commonly one half of the side burner, fails to ignite quickly, adjust the position of the igniter, bearing in mind that propane is heavier than air. The best burner behavior test assessment is done against an inert surface (to spread the gas as it would during an actual test).

when set near the correct flow values. A value roughly in the range of 1 kPa to 3 kPa - 5 in to 15 in of water - can be expected.) Useful guidelines for calibration are provided in Appendix A.

(ix) *Gas flow rate.* Use propane gas with a known net heat of combustion of 46.5 ± 0.5 MJ/kg (nominally 99 % to 100 % propane). Each burner has a specific propane gas flow rate set with its respective, calibrated flowmeter. The gas flow rate to the top burner is 12.9 liters per minute ("L/min") ± 0.1 L/min at a pressure of 101 ± 5 kPa (standard atmospheric pressure) and a temperature of 22 ± 3 °C. The gas flow rate to the side burner is 6.6 ± 0.05 L/min at a pressure of 101 ± 5 kPa (standard atmospheric pressure) and a temperature of 22 ± 3 °C. For the flowmeters supplied with the burner assembly, the black float setting for the top burner is expected to be in the 85 mm to 95 mm range. For the side burner, the expected range for the black float is 115 m to 125 mm. The total heat release rate of the burners is 27 kW.

(b) *Conditioning.* Remove the specimens from any packaging prior to conditioning. Specimens shall be conditioned in air at a temperature greater than 18° C (65° F) and a relative humidity less than 55 percent for at least 48 continuous hours prior to

test. Specimens shall be supported in a manner to permit free movement of air around them during conditioning.

(c) *Test preparation.* (i) *General.* Horizontal air flow at a distance of 0.5 m (20 in) on all sides of the test specimen at the mattress top height shall be ≤ 0.5 m/s. If there is any visual evidence that the burner flames are being shifted around during their exposure durations, the burner regions must be enclosed on two or more sides by a least a triple layer of screen wire. The screen(s) for the top burner shall sit on the mattress top but must be far enough away (typically 30 cm or more) so as not to interfere or interact with flame spread during the burner exposure. The screen for the side burner will require a separate support from below. All screens shall be removed at the end of the 70 second exposure interval.

(ii) *Specimen.* Remove the test specimen from the conditioning room immediately before it is to be tested. Be sure the bed frame is approximately centered on the catch surface. Place the specimen on the bed frame. Carefully center them on the bed frame and on each other. The mattress shall be centered on top of the foundation (see Figure 1). However, in order to keep the heat flux exposure the same for the sides of the two components, if the mattress is 1 cm to 2 cm

narrower than the foundation, the mattress shall be shifted so that the side to be exposed is in the same plane as the foundations. Refer to Figure 8. A product having an intended sleep surface on only one side shall be tested with the sleeping side up so that the sleeping surface is exposed to the propane burner.

(d) *Burner flow rate/flow timer confirmation.* Just prior to moving the burner adjacent to the test specimen, briefly ignite each burner at the same time, and check that the propane flow to that burner is set at the appropriate level on its flowmeter to provide the flows listed in § 1633.7(a)(5)(ix) above. Check that the timers for the burner exposures are set to 70 seconds for the top burner and 50 seconds for the side burner. For a new burner assembly, check the accuracy of the gas flow timers against a stop watch at these standard time settings. Set pilot flows to a level that will not cause them to impinge on sample surfaces.

(e) *Location of the Gas Burners.* Place the burner heads so that they are within 300 mm (1 ft) of the mid-length of the mattress. The general layout for the room configuration is shown in Figure 2. For a quilted mattress top the stand-off foot pad must alight on a high, flat area between dimples or quilting

thread runs. The same is to be true for the side burner if that surface is quilted. If a specimen design presents a conflict in placement such that both burners cannot be placed between local depressions in the surface, the top burner shall be placed at the highest flat surface.

(f) *Burner Set-Up.* The burners shall be placed in relation to the mattress and foundation surfaces in the manner shown in Fig. 9, i.e., at the nominal spacings shown there and with the burner tubes nominally parallel[3] to the mattress surfaces on which they impinge. Since the heat flux levels seen by the test specimen surfaces depend on burner spacing, as well as gas flow rate, care must be taken with the set-up process.

(g) *Burner alignment procedure.* (1) Preparation. Complete the following before starting the alignment procedure:

(i) Check that the pivot point for the mattress top burner feed tube and the two metal plates around it are clean and well-lubricated so as to allow smooth, free movement.

(ii) Set the two burners such that the 5° out-of-plane angling of the flame jets makes the jets on the two burners point slightly toward each other.

[3] The top burner will tend to be tangential to the mattress surface at the burner mid-length; this orientation will not necessarily be parallel to the overall average mattress surface orientation nor will it necessarily be horizontal. This is a result of the shape of the mattress top surface.

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(iii) Check the burner stand-off feet for straightness and perpendicularity between foot pad and support rod and to see that they are clean of residue from a previous test.

(iv) Have at hand the following items to assist in burner set-up: the jig, shown in Fig. 10, for setting the stand-off feet at their proper distances from the front of the burner tube; a 3 mm thick piece of flat stock (any material) to assist in checking the parallelness of the burners to the mattress surfaces; and a 24 gage stainless steel sheet metal platen that is 30 mm (12 in) wide, 610 mm (24 in) long and has a sharp, precise 90° bend 355 mm (14 in) from one 30 mm wide end.

(2) *Alignment.* (i) Place the burner assembly adjacent to the test specimen. Place the sheet metal platen on the mattress with the shorter side on top. The location shall be within 30 cm (1 ft) of the longitudinal center of the mattress. The intended location of the stand-off foot of the top burner shall not be in a dimple or crease caused by the quilting of the mattress top. Press the platen laterally inward from the edge of the mattress so that its side makes contact with either the top and bottom tape edge or the vertical side of the mattress.[4]

[4] Mattresses having a convex side are treated separately since the platen cannot be placed in the above manner. Use the platen only to set the top burner parallelness. Set the in/out distance of the top burner to the specification in step 3 above. Set the side burner so that it is approximately (visually) parallel to the flat side surface of the foundation

Use a 20 cm (8 in) strip of duct tape (platen to mattress top) to hold the platen firmly inward in this position.

(ii) With both burner arms horizontal (pinned in this position), fully retract the stand-off feet of both burners and, if necessary, the pilot tubes as well[5]. (Neither is to protrude past the front face of the burner tubes at this point.) Move the burner assembly forward (perpendicular to the mattress) until the vertical burner lightly contacts the sheet metal platen. Adjust the height of the vertical burner on its vertical support column so as to center the tube on the crevice between the mattress and the foundation. (This holds also for pillow top mattress tops, i.e., ignore the crevice between the pillow top and the main body of the mattress.)[6] Adjust the height of the horizontal burner until it sits lightly on top of the sheet metal platen. Its burner arm should then be horizontal.

(iii) Move the horizontal burner in/out (loosen the thumb screw near the pivot point) until the outer end of the burner tube is 13 mm to 19 mm (1/2 in to 3/4 in) from the corner bend

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below the mattress/foundation crevice once its foot is in contact with the materials in the crevice area. The burner will not be vertical in this case. If the foundation side is also non-flat, set the side burner vertical (± 3 mm, as above) using a bubble level as a reference. The side surface convexities will then bring the bowed out sections of the specimen closer to the burner tube than the stand-off foot.

[5] The pilot tubes can normally be left with their ends just behind the plane of the front of the burner tube. This way they will not interfere with positioning of the tube but their flame will readily ignite the burner tubes.

in the platen (this is facilitated by putting a pair of lines on the top of the platen 13 mm and 19 mm from the bend and parallel to it). Tighten the thumb screw.

(iv) Make the horizontal burner parallel to the top of the platen (within 3 mm, 1/8 in over the burner tube length) by bending the copper tube section appropriately. Note: After the platen is removed (Step 7 below), the burner tube may not be horizontal; this is normal. For mattress/foundation combinations having nominally flat, vertical sides, the similar adjustment for the vertical burner is intended to make that burner parallel to the sides and vertical. Variations in the shape of mattresses and foundations can cause the platen section on the side to be non-flat and/or non-vertical. If the platen is flat and vertical, make the vertical burner parallel to the side of the platen (± 3 mm) by bending its copper tube section as needed. If not, make the side burner parallel to the mattress/foundation sides by the best visual estimate after the platen has been removed.

(v) Move the burner assembly perpendicularly back away from the mattress about 30 cm (1 ft). Set the two stand-off feet to their respective distances using the jig designed for this

[6] For tests of the mattress alone, set the side burner mid-height equal to the lower tape edge of the mattress.

purpose. Install the jig fully onto the burner tube (on the same side of the tube as the stand-off foot), with its side edges parallel to the burner feed arm, at about the position where one end of the foot will be. Loosen the set screw and slide the foot out to the point where it is flush with the bottom end of the jig. Tighten the set screw. Make sure the long axis of the foot is parallel to the burner tube. It is essential to use the correct side of the spacer jig with each burner. Double check this. The jig must be clearly marked.

(vi) Set the downward force of the horizontal burner. Remove the retainer pin near the pivot. While holding the burner feed arm horizontal using a spring scale[7] hooked onto the thumbscrew holding the stand-off foot, move the small and/or large weights on the feed tube appropriately so that the spring scale reads 170 g to 225 g (6 oz to 8 oz).

(vii) Remove the sheet metal platen (and tape holding it).

(viii) Hold the horizontal burner up while sliding the burner assembly forward until its stand-off foot just touches the mattress and/or the foundation[8], then release the horizontal

[7] An acceptable spring scale has a calibrated spring mounted within a holder and hooks on each end.

[8] The foot should depress the surface it first contacts by no more than 1 mm to 2 mm. This is best seen up close, not from the rear of the burner assembly. However, if a protruding tape edge is the first item contacted, compress it until the foot is in the plane of the mattress/foundation vertical sides. The intent here is that the burner be spaced a fixed distance from the vertical mattress/foundation sides, not from an incidental protrusion. Similarly, if there is a wide crevice in this area which would allow the foot to move inward and thereby place the burners too close to the

burner. The outer end of the burner tube should extend at least 6 mm to 12 mm (1/4 in to 1/2 in) out beyond the uppermost corner/edge of the mattress so that the burner flames will hit the tape edge. (For a pillow top mattress, this means the outer edge of the pillow top portion and the distance may then be greater than 6 mm to 12 mm.) If this is not the case, move the burner assembly (perpendicular to the mattress side) - not the horizontal burner alone - until it is. Finally, move the vertical burner tube until its stand-off foot just touches the side of the mattress and/or the foundation. (Use the set screw near the vertical burner pivot.)

(ix) Make sure all thumbscrews are adequately tightened. Care must be taken, once this set-up is achieved, to avoid bumping the burner assembly or disturbing the flexible lines that bring propane to it.

(x) If there is <u>any</u> indication of flow disturbances in the test facility which cause the burner flames or pilot flames to move around, place screens around the burners so as to minimize these disturbances[9]. These screens (and any holders) must be far enough away from the burners (about 30 cm or more for the top,

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vertical mattress/foundation sides, it will be necessary to use the spacer jig (rather than the stand-off foot) above or below this crevice to set the proper burner spacing. Compress the mattress/foundation surface 1 mm to 2 mm when using the jig for this purpose.

less for the side) so that they do not interact with the flames growing on the specimen surfaces. For the top surface burner, at least a triple layer of window screen approximately 30 cm high sitting vertically on the mattress top (Fig. 9) has proved satisfactory. For the side burner at least a triple layer of screen approximately 15 cm wide, formed into a square-bottom U-shape and held from below the burner has proved satisfactory. Individual laboratories will have to experiment with the best arrangement for suppressing flow disturbances in their facility.

(xi) Proceed with the test (see Test Procedure below and Appendix B).

(h) *Running the test.* (1) Charge the hose line to be used for fire suppression with water.

(2) Ignite the pilot lights on both burners and make sure they are small enough as to not heat the test specimen surfaces significantly.

(3) With the calorimetry system fully operational, after instrument zeroes and spans, start the video lights and video camera and data logging systems two minutes before burner ignition (or, if not using video, take a still photograph of the setup).

[9] The goal here is to keep the burner flames impinging on a fixed area of the specimen surface rather than wandering

(4) Start the burner exposure by activating power to the burner timers. Also start a 30 minute timer of the test duration. If not using video, one photo must be taken within the first 45 seconds of starting the burners.

(5) When the burners go out (after 70 seconds for the longer exposure), carefully lift the top burner tube away from the specimen surface, producing as little as possible disturbance to the specimen. Remove the burner assembly from the specimen area to facilitate the video camera view of the full side of the specimen. In the case of the room-based configurations, remove the burner assembly from the room to protect it. Remove all screens.

(i) Video Recording/Photographs. Place a video or still frame camera so as to have (when the lens is zoomed out) just slightly more than a full-length view of the side of the test specimen being ignited, including a view of the flame impingement area while the burner assembly is present. The view must also include the catch pan so that it is clear whether any melt pool fire in this pan participates significantly in the growth of fire on the test specimen. The camera shall include a measure of elapsed time to the nearest 1 second for video and 1

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back and forth over a larger area.

minute for still frame within its recorded field of view (preferably built-in to the camera). For the room-based configuration, the required full-length view of the sample may require an appropriately placed window, sealed with heat resistant glass, in one of the room walls. Place the camera at a height just sufficient to give a view of the top of the specimen while remaining under any smoke layer that may develop in the room. The specimen shall be brightly lit so that the image does not lose detail to over-exposed flames. This will require a pair or more of 1 kW photo flood lights illuminating the viewed side of the specimen. The lights may need to shine into the room from the outside via sealed windows.

(j) Cessation of Test. (1) The heat release rate shall be recorded and video/photographs taken until either 30 minutes has elapsed since the start of the burner exposure or a fire develops of such size as to require suppression for the safety of the facility.

(2) Note the time and nature of any unusual behavior that is not fully within the view of the video camera. This is most easily done by narration to a camcorder.

(3) Run the heat release rate system and datalogger until the fire has been fully out for several minutes to allow the system zero to be recorded.

§ 1633.8 Findings.

(a) *General.* In order to issue a flammability standard under the FFA, the FFA requires the Commission to make certain findings and to include these in the regulation, 15 U.S.C. 1193(j)(2). These findings are discussed in this section.

(b) *Voluntary standards.* No findings concerning compliance with and adequacy of a voluntary standard are necessary because no relevant voluntary standard addressing the risk of injury that is addressed by this regulation has been adopted and implemented.

(c) *Relationship of benefits to costs.* The Commission estimates the potential total lifetime benefits of a mattress that complies with this standard to range from $62 to $74 per mattress (based on a 10 year mattress life and a 3% discount rate). The Commission estimates total resource costs of the standard to range from $13 to $44 per mattress. This yields net benefits of $18 to $62 per mattress. The Commission estimates that aggregate lifetime benefits associated with all mattresses produced the first year the standard becomes effective range

from $1,560 to $1,880 million, and that aggregate resource costs associated with these mattresses range from $320 to $1,110 million, yielding net benefits of about $450 to $1,560 million. Accordingly, the Commission finds that the benefits from the regulation bear a reasonable relationship to its costs.

(d) *Least burdensome requirement.* The Commission considered the following alternatives: alternative maximum peak heat release rate and test duration, alternative total heat released in the first 10 minutes of the test, mandatory production testing, a longer effective date, taking no action, relying on a voluntary standard, and requiring labeling alone (without any performance requirements). The alternatives of taking no action, relying on a voluntary standard (if one existed) requiring labeling alone are unlikely to adequately reduce the risk. Requiring a criterion of 25 MJ total heat release during the first 10 minutes of the test instead of 15 MJ would likely reduce the estimated benefits (deaths and injuries reduced) without having much effect on costs. Both options of increasing the duration of the test from 30 minutes to 60 minutes and decreasing the peak rate of heat release from 200 kW to 150 kW would likely increase costs significantly without substantial increase in benefits. Requiring production testing

would also likely increase costs. Therefore, the Commission finds that an open flame standard for mattresses with the testing requirements and criteria that are specified in the Commission rule is the least burdensome requirement that would prevent or adequately reduce the risk of injury for which the regulation is being promulgated.

§ 1633.9 Glossary of Terms.

(a) Absorbent pad. Pad used on top of mattress. Designed to absorb moisture/body fluids thereby reducing skin irritation, can be one time use.

(b) Basket pad. Cushion for use in an infant basket.

(c) Bunk beds. A tier of beds, usually two or three, in a high frame complete with mattresses (see fig. 11).

(d) Car bed. Portable bed used to carry a baby in an automobile.

(e) Carriage pad. Cushion to go into a baby carriage.

(f) Chaise lounge. An upholstered couch chair or a couch with a chair back. It has a permanent back rest, no arms, and sleeps one (see fig. 11).

(g) Convertible sofa. An upholstered sofa that converts into an adult sized bed. Mattress unfolds out and up from under the seat cushioning (see fig. 11).

(h) Corner groups. Two twin size bedding sets on frames, usually slipcovered, and abutted to a corner table. They also usually have loose bolsters slipcovered (see fig. 11).

(i) Crib bumper. Padded cushion which goes around three or four sides inside a crib to protect the baby. Can also be used in a playpen.

(j) Daybed. Daybed has foundation, usually supported by coil or flat springs, mounted between arms on which mattress is placed. It has permanent arms, no backrest, and sleeps one (see fig. 11).

(k) Dressing table pad. Pad to cushion a baby on top of a dressing table.

(l) Drop-arm loveseat. When side arms are in vertical position, this piece is a loveseat. The adjustable arms can be lowered to one of four positions for a chaise lounge effect or a single sleeper. The vertical back support always remains upright and stationary (see fig. 11).

(m) Futon. A flexible mattress generally used on the floor that can be folded or rolled up for storage. It usually consists of resilient material covered by ticking.

(n) High riser. This is a frame of sofa seating height with two equal size mattresses without a backrest. The frame slides

out with the lower mattress and rises to form a double or two single beds (see fig. 11).

(o) Infant carrier and lounge pad. Pad to cushion a baby in an infant carrier.

(p) Mattress foundation. This is a ticking covered structure used to support a mattress or sleep surface. The structure may include constructed frames, foam, box springs or other materials used alone or in combination.

(q) Murphy Bed. A style of sleep system where the mattress and foundation are fastened to the wall and provide a means to retract or rotate the bed assembly into the wall to release more floor area for other uses.

(r) Pillow. Cloth bag filled with resilient material such as feathers, down, sponge rubber, urethane, or fiber used as the support for the head of a person.

(s) Playpen pad. Cushion used on the bottom of a playpen.

(t) Portable crib. Smaller size than a conventional crib. Can usually be converted into a playpen.

(u) Quilted means stitched with thread or by fusion through the ticking and one or more layers of material.

(v) Roll-away-bed. Portable bed which has frame that folds with the mattress for compact storage.