Tab F

Preliminary Environmental Assessment of a Draft Proposed Open-Flame Ignition Resistance Standard for Mattresses

Robert Franklin
Directorate for Economic Analysis
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Preliminary Environmental Assessment of an Open-Flame Ignition Resistance Standard for Mattresses

Background

This memorandum discusses the potential environmental impact of a performance standard for residential mattresses intended to decrease deaths and injuries from mattress fires. Generally, U.S. Consumer Product Safety Commission (CPSC) rules establishing performance requirements are considered to "have little or no potential impact for affecting the human environment" and environmental assessments are not usually prepared for these rules (see 16 CFR § 1021.5 (c)(1)). However, in order to meet this standard, manufacturers will need to change some materials that they use to manufacture mattresses: either using more inherently flame resistant materials or incorporating flame retardant (FR) chemicals into their products. Therefore, a more thorough consideration of the potential for environmental impacts is warranted.

This analysis concludes that since the standard is a performance standard, manufacturers will have several options for meeting the requirements of the standard. Although there are still some unsettled questions, there appear to be several promising methods that manufacturers could use without posing an unacceptable health risk to consumers or significantly affecting the environment. Moreover, even if a chemical used by some manufacturers is shown to pose an unacceptable risk to human health or the environment, there are various regulatory and other mechanisms that could be used to remove the chemical from applications where it poses a risk.

Requirements of the Draft Proposed Standard

The standard would establish a test protocol that a prototype of a mattress would have to pass before mattresses of that type could be sold. Essentially, the protocol calls for a mattress prototype to be exposed to a large open flame ignition source for 70 seconds. The heat release from any resulting fire is then monitored for 30 minutes. The mattress passes if the heat release rate does not exceed 200 kW at any time during the 30 minute test and the total heat released does not exceed 15 mega joules in the first 10 minutes of the test.

The intent of the standard is to increase the time it takes a mattress fire to reach "flashover," a point where virtually every combustible material in the room is ignited almost instantaneously. Mattress components have a high fuel load and, if ignited, can rapidly bring a room to flashover. Once flashover has occurred, anyone in the room (or even adjacent rooms) has little chance of survival. By limiting the maximum heat release rate to under 200 kW for at least 30 minutes, the standard reduces the chance that flashover will occur during that period. This will give any people in the dwelling a greater chance of escape.

Alternatives for Meeting the Draft Proposed Standard

The standard does not prescribe the means that manufacturers must use to meet the standard. It is expected, however, that most manufacturers will use some kind of flame resistant barrier to protect the mattress components with the greatest combustible fuel loads from the flames. These barriers may be fabric, batting, or other materials that are either inherently flame resistant or that have been treated with flame retardant chemicals. For example, one alternative might be to use a fabric or batting made with an inherently flame resistant fiber, such as a para-aramid or fiberglass. Another alternative might be to use materials that have been treated with flame retardant chemicals, such as boric acid or decabromodiphenyl oxide (DBDPO).

A flame resistant barrier could be substituted for other materials in the mattress. For example, a manufacturer may substitute a flame resistant fabric for the mattress ticking now being used or substitute batting treated with flame retardant chemicals for untreated batting. Alternatively, the fire resistant barrier could consist of an additional layer underneath the mattress ticking, but surrounding other filling materials. In this case the mattress ticking and other "sacrificial layers," such as a foam or "pillow top" mattress pad would be consumed in a fire, but the fire barrier would protect the components with the highest fuel load. Another alternative is to ensure the core filling materials themselves are fire resistant. For example, foams or batting materials could be treated with fire retardant chemicals. This alternative could be used alone or in combination with a flame resistant barrier.

Where the Draft Proposed Standard Can Impact the Environment

About 22 million bed sets (mattresses and foundations) are sold annually and most will probably require some changes in materials used or construction to meet the standard. These changes, such as the incorporation of a flame resistant barrier or other materials, will increase the manufacture of fire resistant materials or FR chemicals. Raw materials must be extracted, processed, refined, and converted. This involves energy consumption, labor, and the use of chemicals, some of which could be toxic. For example, melamine fibers are a potential component of flame resistant barriers for mattresses. Producing melamine fibers involves reacting melamine with formaldehyde. Therefore, the increase in demand for melamine fibers attributable to the standard could increase the risk of worker exposure to formaldehyde or for releases of formaldehyde from the manufacturing facilities, depending on the processes or controls used.

The completed materials must be shipped to the mattress manufacturers and the mattress manufacturers must incorporate the material into the mattress. Workers at the mattress manufacturing facilities could be exposed to chemicals used to meet the standard. The exposures could be dermal (e.g., from handling the fabric) or inhalation (e.g., from inhaling small pieces of fibers or dust). Scrap and waste material will be generated which will have to be either recycled or disposed of through incineration or at a landfill.

The finished mattresses or bed sets can be expected to remain in the homes of consumers for more than 10 years. During this time, consumers could be exposed to any chemicals used to

meet the standard. The exposure could be through dermal contact with the mattress, mouthing of the mattress (e.g., by small children), or though the inhalation of dust or emissions from the mattress. Because a mattress will likely be replaced by another mattress, consumers will effectively be exposed to mattresses and bed sets that meet the standard throughout their lives.

At the end of their useful lives, mattress and bed sets will be disposed of, most likely in a landfill or by incineration. The potential for adverse environmental impacts from disposal can vary depending on the method used to meet the standard. For example, some flame retardant chemicals could dissolve in water and migrate with the water. Others might be more tightly bound to soil particles and stay in the landfill. Some FR chemicals are persistent in the environment and may bioaccumulate, which could eventually pose toxicity problems. However, other FR chemicals have a low potential for bioaccumulation.

It should be noted that the draft proposed standard is very similar to a State of California standard referred to as "CA Technical Bulletin 603" (or CA TB 603). Beginning on 1 January 2005, all mattresses sold in California must meet CA TB 603. Because California is a large market, most mattress manufacturers are in the process of developing and bringing to market products that will meet the California standard. At least one major manufacturer is already distributing mattresses that meet CA TB 603 nationwide. Therefore, the potential environmental impact described in this report is likely to occur irrespective of any Commission action to promulgate a mattress flammability standard.

How Significant Will the Environmental Impacts of the Draft Proposed Standard Be?

There appear to be several promising methods that manufacturers could use to meet the standard that are not likely to have a significant adverse impact on the environment. However, since manufacturers are now evaluating their alternatives, the staff does not know the methods that each manufacturer will use to meet the standard. Therefore, the approach that is used in this discussion is to attempt to provide some context for considering the environmental impacts of the standard. More definitive conclusions should be possible as more information is received concerning the methods that manufacturers will use to meet the standard and some of the gaps in our knowledge of the health and environmental impacts of the alternatives are closed.

Some FR Chemicals Can Have Adverse Impacts

Some chemicals that have been used for their fire resistant properties have been determined to have unacceptable adverse impacts on health and the environment in some applications. For example, some children's sleepwear manufacturers treated their product with a chemical called tris (2,3,-dibromopropyl) phosphate ("TRIS") in order to meet a flammability standard. The CPSC later determined that TRIS posed a cancer risk and acted to ban the sale of children's clothing treated with the chemical in 1977.[1] A group of bromine-based FR chemicals

[1] The ban of TRIS was blocked by the courts on procedural grounds. However, the Commission's authority to ban TRIS was not at issue. Children's sleepwear manufacturers stopped using TRIS voluntarily.

called "polybrominated biphenyls" were used as flame retardants until questions regarding their safety were raised in the 1970s and manufacturers voluntarily ended their production. Another class of bromine-based flame retardants was developed to replace them: polybrominated diphenyl oxides (also referred to as polybrominated diphenyl ethers or "PBDEs").[2] However, some PBDEs have been found to be persistent and bioaccumulative.[3] A major manufacturer of PBDEs is voluntarily ceasing production of two PBDEs: pentabromodiphenyl oxide (PBDPO) and octabromodiphenyl oxide (OBDPO).[4] The European Union and the States of California, Hawaii, and Maine have recently enacted bans on the use of PBDPO and OBDPO that will be taking effect over the next couple of years.[5]

Fire Resistant Chemicals and Materials are Widely Used

While some fire resistant chemicals and materials have been found to be hazardous and are no longer used, other FR chemicals are widely used. In the US, the consumption of flame retardant chemicals is estimated to be over 1 billion pounds annually and is increasing.[6] This includes various bromine, antimony, chlorine, phosphorous, nitrogen, and boron-based fire retardant chemicals. Additionally, there are some fibers where the FR chemical is incorporated into the polymer of the fiber itself or that are inherently fire resistant. These include some modacrylic, melamine, and para-aramid fibers.

The same manufacturer that is phasing out its production of PBDPO is manufacturing a chemical that can be used as a replacement for it. A preliminary assessment by the U.S. Environmental Protection Agency (EPA) indicates that the new chemical is not persistent, bioaccumulative, or toxic to aquatic organisms.[7] A second manufacturer has also introduced an alternative chemical for PBDPO. In both the cases, the substitute chemicals are bromine and phosphorous-based.

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[2] U.S. Department of Health and Human Services (HHS), Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (Draft for Public Comment), (September 2002). Hereafter cited HHS, ATSDR (2002). p. 292.

[3] Linda S. Birnbaum and Daniele F. Staskal, "Brominated Flame Retardants: Cause for Concern?" Environmental Health Perspectives, Volume 112, Number 1 (January 2004). Hereafter cited "Birnbaum and Staskal (2004)."

[4] "Brominated Flame Retardants To Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

[5] The ban in Maine will take effect on 1 January 2006. The bans in California and Hawaii will take effect on 1 January 2008.

[6] Business Communications Company estimated that U.S. consumption of FR chemicals would reach 969 million pounds in 2003 and was growing at a rate of 5 percent annually (Flame Retardant Chemicals, Report C-004Z, Business Communications Company, Inc., Norwalk, CT, Richard Hilton, Project Analyst, October 1998). The European Flame Retardants Association, citing SRI Consulting, estimated U.S. consumption of FR chemicals to be 1,086 million pounds in 2001 (http://www.cefic-efra.org/frames/f_market_stat.html?=market_stat.html [Information accessed on 4 February 2004. The data were provided in metric tons and converted to pounds using the conversion calculator at www.onlineconversion.com.).

[7] "Brominated Flame Retardants To Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

Because the chemicals and materials that would be used to meet a mattress standard are already being used in other applications, the manufacture of these materials will not create new impacts, but it could intensify effects that are already occurring. For example, emissions or wastes that are produced during manufacture of these chemicals or other materials would increase, but the standard is unlikely to result in different chemicals being released or workers being exposed to different hazards.

A mattress flammability standard could result in some FR chemicals or flame resistant materials being used in applications where they have not been used before. This would result in some new exposure patterns for these materials. For example, workers in mattress factories could be exposed to the chemicals as could the ultimate consumers. However, these new exposure patterns may be similar to ones that are already occurring since these chemicals are widely used in other applications. For example, workers involved in manufacturing protective apparel, carpets, and transportation upholstery may already be exposed to these chemicals as are the consumers of the products. Some of these FR chemicals and materials may already be used in mattress and bedding applications. For example, boric acid is already used to treat cotton batting in mattresses and futons.

Regulatory and Other Protections

Even if some manufacturers use a chemical to meet the standard and that chemical is later determined to pose an unacceptable risk to health or the environment, there are established regulatory mechanisms that can limit or remove the hazard. There is precedent for using such mechanisms with regards to health concerns caused by flame retardant chemicals. For example, when CPSC acted to ban TRIS it did not alter the flammability standards for children's sleepwear; it only removed one option for meeting the standard.

The U.S. Environmental Protection Agency (EPA) has the power to regulate the use of toxic chemicals under the Toxic Substances Control Act (TSCA).[8] It also monitors and promotes research into potential toxic or environmental effects of chemicals which it believes could pose environmental risks. With regard to flame retardants, the EPA is developing a significant new use rule (SNUR), under Section 5(a)(2) of TSCA, which is expected to cover the use of several flame retardants in residential upholstered furniture. A SNUR would require chemical manufacturers and importers to report scientific data to the EPA so that EPA may determine whether controls on the use of the chemical may be warranted. There is expected to be some overlap between the flame retardants that will be covered by the SNUR for use in upholstered furniture and flame retardants that can be used in mattresses. Decabromodiphenyl oxide (DBDPO), for example, can be used as a backcoating in upholstery fabric or on fire resistant barriers for mattresses.

Other EPA activities involve researching and monitoring the use of certain chemicals, including some FR chemicals. These include some voluntary programs, in cooperation with chemical manufacturers, such as the "Voluntary Children's Chemical Evaluation Program" and

[8] 15 U.S.C. s/s 2601 et. seq (1976).

the "High Production Volume Challenge Program."[9] If information is developed during these activities suggesting that a flame retardant could be toxic or have adverse environmental effects if used in mattresses, the EPA could impose controls on the use of the chemical to ensure human or environmental safety.

The National Toxicology Program (NTP) of the Department of Health and Human Services (DHHS) coordinates the toxicological review and testing of chemicals for agencies under the DHHS. Federal and state agencies, academics, advocacy groups, industry representatives, and private citizens may nominate substances for testing under the NTP. The NTP chooses substances for further testing and evaluation based upon factors such as the extent of human exposure and the degree of suspicion of toxicity and the extent of any toxicological data gaps. Agencies such as the EPA and CPSC may use the results of NTP testing to regulate a substance if the results indicate that it could be toxic. The NTP has examined or is evaluating some flame retardant chemicals, including several PBDEs.

The Occupational Safety and Health Administration (OSHA) has the authority to regulate hazards to worker health. It has established "permissible exposure levels" (PELs) for some chemicals in the workplace. Should OSHA determine that worker exposure to any FR chemical used to meet the standard poses a risk to worker health, it could issue standards to mitigate the risk.

Several advocacy groups have researched and monitored flame retardants and other chemicals for human and environmental toxicity. These parties often publicize their findings and advocate for regulations when they find potential problems.[10] Manufacturers also have incentives to investigate the potential toxicity of their products, both to avoid liability for damage caused by their products and to ensure that they have other marketable products should some be removed from the market. As previously noted, some manufacturers have voluntarily stopped the manufacture of flame retardants when questions have been raised about their toxicity or environmental effects. Chemical manufacturers are actively developing alternative chemicals and are cooperating with the EPA to ensure that these are less harmful than the ones that they are replacing.[11]

In summary, several regulatory agencies, advocacy groups, and industry participants have mandates or interests in monitoring the use of chemicals that may be toxic or have adverse impacts on the environment. Because of this monitoring, controls have been placed on the use of several chemicals, including some flame retardants. Today, many of these agencies or organizations are involved in researching the potential toxicity and environmental impact of some bromine-based flame retardants, such as the PBDEs. Taken together, these regulatory agencies, advocacy groups and industry participants provide mechanisms for banning or

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[9] See the Federal Register, Vol. 65, No. 248, pp. 81686-81718, (26 December 2000).

[10] For example, the Environmental Working Group has recently published several reports on PBDE flame retardants: Tainted Catch (2003), Mothers Milk (2003), and In the Dust (2004). These are available at http://www.ewg.org.

[11] "Brominated Flame Retardants To Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

establishing other controls on the use of substances that are determined to pose unacceptable risks to human health or environmental harm.

Environmental Impacts of Some Methods That May Be Used by Mattress Manufacturers

This section provides a brief discussion of what is known of the potential toxicity and environmental impacts of a few of the methods that manufacturers might use to meet the standard. The methods of which the staff is aware that are likely to be used by some manufacturers include the use of barriers containing cotton treated with either boric acid or diammonium phosphate (DAP) and barriers containing modacrylic, melamine, para-aramid, polyetherimide, or Visal® fibers.[12] Another method is to use a fabric barrier that has been backcoated with FR chemicals such as decabromodiphenyl oxide or antimony trioxide. However, industry knowledge of the methods available for meeting the standard is increasing. It is therefore possible that new methods will be developed and that some of the above methods that are currently being considered may not be used in the end.

Boric Acid-Treated Cotton Fabric or Batting

Boric acid is widely used, including in applications as a pesticide inside and outside the home and on food crops. Boron, a component of boric acid, is a plant nutrient at low levels but toxic to plants at high levels. Borates, including boric acid, are used in the manufacture of products such as fiberglass, ceramics, fertilizers, and detergents. Moreover, many boron compounds can naturally form boric acid in the environment. Boric acid is of low toxicity to most wildlife and is considered to have a low potential to build up in the tissues of animals.[13] It may be more toxic to some invertebrates.[14]

Boric acid treated cotton fabric and batting has been widely used in mattresses for several decades to meet existing requirements for cigarette ignition resistance. It is also used to comply with the requirements of some existing mattress flammability standards, such as CA TB 129, intended for mattresses used in public facilities, such as prisons, dormitories, health care facilities, and other public facilities.[15]

Boric acid-treated cotton batting is about 10 percent boric acid by weight. According to one industry source, only a few pounds of cotton batting per queen-sized mattress are required. Thus, only a few ounces of boric acid per queen-sized mattress would be used. Even if all

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[12] Some manufacturers may use more than one method to meet the standard. For example, some FR barriers may contain melamine, modacrylic, and Visal® fibers.

[13] Boric Acid, General Fact Sheet, National Pesticide Telecommunications Network (NPTN). NPTN is sponsored by Oregon State University and the U.S. Environmental Protection Agency. The fact sheets are available at http://npic.orst.edu/npicfact.htm.

[14] ChemicalWATCH Factsheet: Boric Acid, Beyond Pesticides, available at www.beyondpesticides.org.

[15] Although developed by the California Bureau of Home Furnishings and Thermal Insulation, CA TB 129 is not mandated by California law, but some local jurisdictions and individual institutions mandate the use of mattresses that comply with its requirements.

mattress manufacturers used boric acid-containing barriers to meet a flammability standard it would require less than 3 percent of the total annual consumption of boric acid in the US, which exceeds 260,000 metric tons annually.[16]

The CPSC Directorate for Health Sciences expects that the amount of boric acid that would be released from a mattress would be lower than would be needed to cause any health effects. However, because of the potential developmental effects of boric acid and because the amounts released from a mattress, while low, may be higher compared to FR chemicals incorporated directly into a fiber, more data about potential boric releases would be desirable.[17] CPSC staff may conduct tests to measure the potential consumer exposure to boric acid used in FR barriers in mattresses.

DAP-treated Cotton Fabric

Although its historical use as an FR chemical in mattresses appears to be less common than that of boric acid, DAP can also be used to treat cotton fabric for use in an FR barrier. CPSC staff believes that some mattress manufacturers may be considering the use of a barrier that incorporates DAP-treated cotton fabric to meet the standard.

The primary use of DAP is as an agricultural fertilizer. Several million tons of DAP are applied to crops annually in the United States. Less than 5 percent of the DAP produced annually is used for other purposes, including as a flame retardant and a food additive. Because its use as a fertilizer involves its intentional release into the environment, its use in mattresses is unlikely to have any incremental adverse impact on the environment in general. The National Academy of Sciences concluded that, although there were some data gaps concerning chronic toxicity, the class of chemicals to which DAP belongs (ammonium polyphosphates) probably were not potent toxicants based on acute studies. With regards to their potential use to meet an upholstered furniture flammability standard (which would represent a similar consumer exposure pattern as mattresses), the NAS concluded that no further research was needed to assess the health risks from ammonium polyphosphates.[18]

Modacrylic Fiber Barriers

CPSC staff believes that some manufacturers will use barriers containing modacrylic fibers to meet the standard. Modacrylic fibers are a copolymer fiber containing between 50 and 84 percent acrylonitrile units and another material, such as vinylidine chloride. Modacrylic fibers

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[16] Based on the annual production of one of the two boric acid manufacturers in the U.S. (Rio Tinto Borax Press Release, "Borax Build Boric Acid Capacity to Meet Growing Demand" (11 August 2003). Available at http://www.borax.com/news35.html.

[17] Treye A. Thomas and Patricia Brundage, "Qualitative Assessment of Potential Health Effects From the Use of Flame Retardant Chemicals in Mattresses," CPSC Memorandum to Margaret Neilly, 22 September 2004 (DRAFT). Hereafter cited "Thomas and Brundage (2004)."

[18] National Academy of Sciences, Toxicological Risks of Selected Flame-Retardant Chemicals, National Academy Press, Washington, DC (2000).

are often described as being "inherently flame retardant," but in some cases chemicals such as antimony trioxide are also added to the polymer to enhance the FR properties of the fiber. The chemicals used in modacrylic fibers are part of the polymer matrix and therefore, consumer exposure to the chemicals is expected to be low. Therefore, the risk of any adverse health effects to consumers from the use of modacrylic fibers is expected to be low.[19] Modacrylic fibers have been used since the 1940s and are widely used in textile applications including children's sleepwear, synthetic fleece, and fake fur and hair.

Melamine Fiber Barriers

Some manufacturers are expected to use barriers that incorporate melamine fibers. Melamine resins are already used in a wide variety of consumer products including the laminates used in kitchen counter tops and in plastic cooking utensils. Fibers produced from melamine resins are already used in some protective apparel and as FR barriers in some upholstered furniture intended for institutional use and aircraft seating. The potential for consumer exposure to melamine resulting from its use in FR barriers in mattresses is low because the material is incorporated into a polymer.[20]

Para-aramid Fibers

Para-aramid fibers (e.g., Kevlar®) are used in flame resistant clothing, protective equipment (e.g., helmets and bullet proof vests), in addition to some industrial uses. Some mattress manufacturers might use FR barriers that incorporate some para-aramid fibers. Additionally, thread made out of para-aramids may have to be used in some mattress applications to maintain the integrity of the FR barriers in a fire.

Para-aramid fibers themselves are inherently flame resistant. The risks to human health or the environment resulting from the use of para-aramid fiber barriers in mattresses, if any, would be expected to be similar to the risks of using the fibers in the other applications in which they are used. This includes the risks, if any, to workers and from the ultimate disposal of the products.

Polyetherimide Resin Barriers

Some manufacturers may use barriers that incorporate polyetherimide resin. According to a manufacturer of polyetherimide plastic resins, they are inherently flame resistant, have low toxicity, and produce a low quantity of smoke during fires. Polyetherimide resins are used in many applications in airliners because of their inherent FR properties.[21]

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[19] Thomas and Brundage (2004).

[20] Thomas and Brundage (2004)

[21] Information presented in a meeting between CPSC staff and representatives of Western NonWovens and GE Advanced Materials on 1 September 2004.

CPSC staff have not conducted its own risk assessment of the use of polyethermide resins in mattresses. However, generally materials that are incorporated into a polymer matrix are thought to have low risk of release and consumer exposure.

Visal® Fiber Barriers

Visal® is an FR fiber produced from rayon, sodium silicate, and other materials.[22] Rayon is a very widely used fiber in textiles made from wood pulp. Sodium silicate is also very widely used. Many household cleaning and detergent products, for example, contain sodium silicate. Visal® fibers have been commercially available since 1992. The manufacturer of Visal® asserts that the product is biodegradable and produces low toxic smoke emissions in a fire.[23]

Decabromodiphenyl Oxide (DBDPO)

DBDPO could be used as a backcoating for a fire-resistant barrier fabric or on the mattress ticking itself. DBDPO is commonly used to treat upholstery fabrics to meet the U.K. upholstered furniture flammability standard. It is often used with antimony trioxide.

Generally, there has been less concern expressed about the toxicity of DBDPO than for some of the lower brominated diphenyl oxides, such as PBDPO. Nevertheless, DBDPO is considered to be toxic by CPSC staff, based upon liver and thyroid effects observed in rodent feeding studies.[24] Some recent research has indicated that DBDPO can debrominate resulting in the formation of lower brominated diphenyl oxides. The lower brominated diphenyl oxides, such as PBDPO, can bioaccumulate in organisms and are suspected of being capable of having toxic effects.[25] There is some speculation that some of the lower brominated PBDEs found in the environment may be the result of DBDPO being broken down. Even more recently, a Norwegian study reported that DBDPO itself has been found in polar bears and gulls in the arctic.[26] This shows that DBDPO can be found in the environment in places that are remote from where it has been manufactured or used. DBDPO is expected to be covered by a significant new use rule under development by the EPA with regards to its use in upholstered furniture. Other research is on going regarding the toxicity and environmental fate of DBDPO. Regulatory mechanisms exist that could be used to control its use if further research shows that significant harm would result from its use to meet a mattress flammability standard.

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[22] David Perry, "Visil's Inherently FR Nature a Marketing Edge, Company Says," Furniture Today, 28 June 2004. (Available at http://furnituretoday.com)

[23] Ibid.

[24] Thomas and Brundage (2004).

[25] Birnbaum and Staskal (January 2004).

[26] See "Worries over chemical in Arctic wildlife," Reuters, 1 June 2004.

An assessment by the National Academies of Sciences concluded that the use of DBDPO to meet an upholstered furniture flammability standard would pose minimal risk to consumers, even under worse case scenarios.[27] A qualitative assessment by CPSC staff concluded that additional laboratory data would be needed to quantify the potential releases of DBDPO to better assess the health risks of using DBDPO-treated barriers in mattresses.[28]

Discussion

The potential methods for meeting the standard discussed above generally involve chemicals or materials that are already widely used in a variety of different applications. Therefore, a mattress flammability standard will not involve the creation of new risks, but could marginally increase environmental exposures or releases that are already occurring due to the use of the FR chemicals or materials in other applications.

Consumer exposure to the FR chemicals and other materials used in a mattress might be somewhat different from their use in other products because consumers can be expected to spend a significant amount of time in close contact with the materials. However, as discussed above, there are already several methods that can be used to meet the standard and that are not anticipated to be a health risk to consumers. Moreover, there will frequently be other layers of protection between the consumer and the FR barriers, such as the mattress ticking, mattress pads, sheets, and so on. These can serve to reduce consumer exposure to any chemicals being released from the barriers.

In a plausible "worst case" scenario, a particular chemical or material that is being used by some manufacturers to meet the standard will be determined to pose an unacceptable health or environmental risk. For example, new evidence might show that the potential consumer exposure to a chemical or material could raise the risk of developing a particular type of cancer above some threshold of concern (e.g., a one in a million) or could exceed the level that toxicologists consider to be an acceptable daily intake to avoid other chronic diseases or injuries. Or, new evidence could show that a particular FR chemical used to meet the mattress standard bioaccumulates, that is the concentrations of the chemical in living organisms are increasing.

If a chemical or material used to meet the standard is determined to present an unacceptable risk, there are regulatory mechanisms that can be used to limit the specific risk. For example, the EPA, OSHA, or the CPSC could establish controls or bans on the use of the specific chemical or material as appropriate. Manufacturers also have economic incentives to avoid the use of chemicals or materials that are believed to pose unacceptable risks. These include incentives to develop alternative products when the safety of another product is questioned to ensure that they have marketable products and to avoid potential product liability litigation.

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[27] National Academy of Sciences, Toxicological Risks of Selected Flame-Retardant Chemicals, National Academy Press, Washington, DC (2000).

[28] Thomas and Brundage (2004).

Such mechanisms have been used when other chemicals used in consumer products have been found to have unacceptable risks. For example, as discussed previously, a flame retardant used in children's sleepwear (tris (2,3,-dibromopropyl) phosphate ("TRIS")) was found to pose an unacceptable risk of cancer. More recently, a chemical used to prevent termite and fungal damage in wood (chromated copper arsenate or "CCA") was found to pose a risk of cancer.[29] As noted earlier PBDPO, which has been used as an FR chemical in polyurethane foam, has been found to bioaccumulate. In each of these cases, regulatory authorities, here and abroad, undertook investigations of the risks, and in some instances took steps towards regulating the use of the chemical. And in each of these cases, manufacturers took steps to stop using the chemicals before final bans or regulations went into effect.[30] Moreover, in each of these cases, substitute chemicals were already available.

Alternatives to the Draft Proposed Standard

The Commission considered two alternatives to the draft proposed standard that could have some impact on the potential environmental impacts. One alternative would have established more severe performance criteria. That alternative would have monitored the heat release during a 60-minute testing period (instead of 30 minutes, as in the staff's proposal) and/or the failure criteria would be if the peak heat release rate exceeded 150 kW (instead of 200 kW as in the proposal). Another alternative considered is for the Commission not to issue a mattress flammability standard.

60-Minute Test Duration/Lower Peak Heat Release Rate

Establishing a 60-minute test duration during which the rate of heat release could not exceed 150 kW would be somewhat more difficult for manufacturers to meet than the proposed 30-minute duration and 200 kW maximum heat release rate. However, CPSC staff believes that manufacturers could use some of the same materials to meet the more severe tests as they would use to meet the one in the draft proposed standard. It might require manufacturers to use some of the materials more intensely.

To meet a 60 minute test, FR barriers might require a higher percentage of the FR fibers than are required to meet the 30 minute test. It is also possible that mattress manufacturers may increase their use of barriers containing melamine and para-aramid fibers. These fibers are generally thought to be more costly methods for meeting the standard, but manufacturers may rely on them more if the test were more severe. On the other hand, it is generally believed that a 60-minute test duration would eliminate the use of boric acid as an option.

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[29] See the CPSC Staff Briefing Package, Petition to Ban Chromated Copper Arsenate (CCA)-Treated Wood in Playground Equipment (Petition HP 1-03), February 2003. Available at http://www.cpsc.gov/library/foia/foia03/brief/cca0.pdf.

[30] Sleepwear manufacturers stopped using TRIS in children's sleepwear even though a CPSC ban was not finalized. The manufacturers of CCA voluntarily requested the EPA to cancel their registrations of CCA, effectively banning the product. Finally, the only US manufacturer of PBDPO has announced that it is voluntarily phasing out its production.

Alternative of Not Issuing a Mattress Flammability Standard

If the Commission opted not to issue a national mattress flammability standard, the potential for environmental impacts might be reduced, but it would not be eliminated. A State of California standard (CA TB 603), which is very similar to the draft proposed standard, becomes effective on 1 January 2005. All mattresses sold in California will have to meet that standard and, as noted earlier, manufacturers are now in the process of developing mattresses that can meet the standard and bringing them to market. One manufacture is already marketing mattresses that meet CA TB 603 nationwide. Other large manufacturers are expected to do likewise to avoid product liability litigation that might be associated with marketing less flame resistant mattresses in some parts of the country.[31] If the Commission opted not to promulgate a flammability standard for mattresses, the potential impacts on the environment would be reduced only to the extent that manufacturers choose to offer separate product lines for sale in California (and other states that might adopt a similar standard) and different product lines for sale in the rest of the United States.

Summary and Conclusion

Manufacturers will have flexibility in meeting the performance requirements of a standard, thus the extent to which each of the various FR chemicals and other alternatives for meeting the standard (e.g., inherently flame-resistant materials) will be used is uncertain. Although some data gaps and uncertainties in our knowledge of some of the health and environmental impacts exist, there are FR chemicals and flame resistant materials that, based on currently available data, are not expected to pose unacceptable risks to the environment and that are widely used in other applications. Therefore, manufacturers probably have alternatives for meeting a mattress flammability standard that will not result in unacceptable adverse impacts to the environment or human health. Moreover, government agencies, advocacy organizations, academics, and chemical manufacturers are monitoring and conducting research on the environmental and health impacts of different FR chemicals and other materials. There are regulatory and other mechanisms that can be used to control the use of specific flame retardants or materials if they are found to pose hazards to the environment or human health.

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[31] Consumer Product Safety Commission, "Preliminary Regulatory Analysis of a Mandatory Standard to Address Open-Flame Ignitions of Mattresses," Soumaya M. Tohamy, Directorate for Economic Analysis, U.S. Consumer Product Safety Commission, Washington, DC (September 2004).

Tab G

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 5, 2004

TO : Margaret L. Neily, ES
Project Manager, Mattress Flammability

THROUGH: Gregory B. Rodgers, PhD., AED, Economics GBR

Dale R. Ray, Acting Senior Staff Coordinator, EC DRR

FROM : Terrance R. Karels, EC TRK

SUBJECT : Updated Mattress Market Information

In 2001, the Commission published an advance notice of proposed rulemaking (ANPR) initiating a standards development proceeding to address the risk of fire from open flame ignition of mattresses. This memo provides updated market information in support of a possible notice of proposed rulemaking (NPR) that would include a flammability standard similar in scope to California Technical Bulletin 603 which addresses open-flame ignition; TB 603 covers mattresses, foundations, futons, and other types of sleep surfaces (such as waterbeds and airbeds) containing sufficient fuel loads which, if ignited, could result in a substantial ("flashover") residential fire.

Trade Association

The International Sleep Products Association (ISPA), of Alexandria, Virginia, represents about 725 wholesales, retailers, and manufacturers of mattresses and foundations. According to the Association, their members account for over 80% of total US sales of these products.

The Sleep Products Safety Council (SPSC), which is affiliated with the ISPA, sponsors research on the potential for reductions in the risk of death and injury associated with open flame ignition of mattresses.

Production

According to industry sources, the top four producers of mattresses and foundations, Serta, Sealy, Simmons, and Spring Air, account for over 50% of total US production of these products. These firms also reportedly operate about 50% of all US production facilities for these products. The remaining production facilities are operated by smaller firms supplying products to regional markets. The South accounts for about 40% of total production facilities, while the remaining 60% is spread throughout the rest of the US.

The **US Census Bureau's** "County Business Patterns, 2001" reported that there were 639 establishments in the US producing mattresses in 2001. This is down from the 661 establishments in 2000, and 800 establishments in 1998. Of the 639 establishments, 354 (55% of the total) employed under 20 workers. Overall, in 2001, the industry employed 25,500 workers, down from 26,200 in 2000.

Trade sources note that there is a large (but unknown) number of mattress refinishers or renovators who use existing mattress components, apply additional padding and covers (but sometimes only putting new fabric over a discarded mattress), and sell "reconditioned" mattresses; these mattresses are not sold back to the original mattress owner. Some states require that such mattresses bear a label indicating that the mattress is reconditioned, but the practice is not required nation-wide.

Another type of mattress renovator obtains the mattress from the owner, removes all the interior padding and supports, reassembles the mattress with new materials (often high-density foam), and returns the mattress to the original owner. The prevalence of, and sales revenues from, this type of mattress renovation service is unknown.

Small Businesses

As noted earlier, the largest four manufacturers of mattresses and foundations account for about 50% of the total number of US establishments producing these products. Thus, of the 639 establishments producing these products in 2001, about 320 would be accounted for by these

four manufacturers. The remainder of the establishments would be operated by middle-sized and smaller firms. The extent of employment in the industry in 2001 was reported by **Census**, as follows:

TABLE 1

US Mattress Manufacturing, 2001

Number of Employees	Number of Establishments
0*	27
1 to 4 employees	128
5 to 9 employees	102
10 to 19 employees	89
20 to 99 employees	170
100 to 499 employees	57
500 or more employees	66
Total	639

* Indicates establishments with no paid employees at the time of the report, but with paid employees at some other time during the year.
Source: US Bureau of the Census (www.census.gov/csd/susb)

It is reasonable to assume that the establishments operated by the four largest manufacturers would be the larger establishments, to take advantage of economies of scale in production. Further, the bulk of the remaining establishments that are not operated by the four largest firms likely would be at the lower end of employment per establishment. After accounting for the number of establishments with the largest number of employees per site, the remainder of the industry would thus employ an average of less than 20 workers in each establishment.

The Small Business Administration guidelines (SBA) define a "small business concern" as one that is "independently owned and operated and not dominant in its field of operation." The SBA also developed criteria on the size of companies, by industry, for firms to be eligible for SBA programs. For firms involved in the manufacture of mattresses, the firm must have less than 500 workers. Thus, assuming that most of the firms (other than the top four manufacturers) consist of a single establishment, there may be on the order of 300 firms that could qualify as "small businesses" under SBA guidelines. Of course, some of these firms may be subsidiaries of

larger corporations and, thus, would not be considered "small businesses" under the SBA guidelines.

Shipments

Conventional sleep surfaces and foundations are typically sold in sets. However, more mattresses are sold annually than foundations; some mattresses are sold as replacements for existing mattresses (without the purchase of a new foundation) or are sold for use in platform beds or other beds that do not require a foundation. The ISPA estimated that mattress shipments in 2002 were 21.5 million, or about 55% of the total number of mattresses and foundations sold. Similarly, ISPA's estimate for 1999 was that 21.3 million mattresses and 17.3 million foundations were shipped for US consumption; mattresses accounted for 55% of the total pieces shipped in 1999.

The ISPA estimates shipments for "adult-sized conventional sleep surfaces," based on information from its members. These estimates include innerspring, foam, and air mattresses, and foundations. The trade statistics *do not* include shipments of certain types of sleep surfaces, including futons, crib mattresses (or juvenile mattresses), sleep sofa inserts, or hybrid water mattresses. Adult-sized "conventional" sleep surfaces reportedly account for *in excess of* 80% of total annual shipments of all sleep products, and the remainder of shipments are of these "non-conventional" sleep surfaces.

The estimated shipments of mattresses over the past 23 years are provided in Table 2. ISPA estimates of industry shipments of the "conventional" mattresses are shown. We have further estimated that the "non-conventional" sleep surfaces not included in the industry estimates totaled 10% of industry totals (the midpoint of the estimated 0-20% range for shipments not reported by ISPA). The ISPA estimates are for mattresses only. Any regulation that requires testing may impact on mattresses and foundations (as sold in sets), mattresses sold separately, and a lesser amount of the non-conventional mattress types. Thus, the staff has used the combined figures for mattresses of all types, including non-conventional mattresses to represent the estimated number of products that may be subject to a proposed rule.

TABLE 2

Estimated Mattress Shipments

In Thousands

Year	Conventional	Non-conventional	Total
1981	11,900	1,300	13,172
1982	11,300	1,300	12,600
1983	12,900	1,400	14,300
1984	13,800	1,500	15,300
1985	14,000	1,500	15,500
1986	14,900	1,600	16,500
1987	16,000	1,800	17,800
1988	16,600	1,800	18,400
1989	16,400	1,800	18,200
1990	16,200	1,700	17,900
1991	16,200	1,700	17,900
1992	16,900	1,800	18,700
1993	17,600	2,000	19,600
1994	18,300	2,000	20,300
1995	18,200	2,000	20,200
1996	18,700	2,000	20,700
1997	19,500	2,100	21,600
1998	20,200	2,200	22,400
1999	21,300	2,400	23,700
2000	21,700	2,400	24,100
2001	21,200	2,400	23,600
2002	21,500	2,400	23,900
2003(e)	22,100	2,500	24,600
2004(e)	22,800	2,500	25,300

Source: IPSA, **2002 U.S. Mattress Industry** for conventional mattresses; non-conventional mattresses were assumed to be 10% of the total industry production.
(e) indicates estimated, based on calculated average annual increase in sales over the period.

Number in Use

To estimate the number of mattresses in use, EC has used the Directorate's **Product Population Model**. The Model incorporates a computer algorithm that estimates the number of products remaining in use, based on the expected useful life of the product, a statistical distribution that describes the rate at which products are removed from use, and historical sales data.

The expected useful life of mattresses can vary substantially, with more expensive models generally experiencing the longest useful lives. Industry sources recommend replacement of mattresses after 10 to 12 years of use, but do not specifically estimate the average life expectancy of these products. An earlier EC market study estimated the expected useful life of mattresses at 14 years, derived from a study conducted for the Commission, the **Product Life Feasibility and Development Study** (Battelle Columbus Laboratories, 1980). For the purposes of this analysis, we have used a range of the expected useful life of mattresses of 10 to 14 years in order to encompass all of these prior estimates. For the statistical distribution, we have assumed that the product failure rate over time would follow a gamma distribution, the distribution that is believed to most closely track the rate at which consumer products are removed from service.

Based on the information in Table 2, mattress shipments have increased about 3% per year in recent years. For this analysis, we have assumed that sales in 2003 and 2004 would be 3% higher than the previous year. The "numbers in use" estimate also requires sales information for some years prior to those for which data are available. For shipments in those prior years, we have assumed sales would be 3% lower per year. The inclusion of total annual sales of conventional and non-conventional sleep surfaces, as shown in the previous table, along with the other parameters listed above results in the following estimate of the number of mattresses in use.

TABLE 3

Estimated Number of Mattresses In Use

Year	If a 10-year useful life	If a 14- year useful life
1994	179.8 million	229.0 million
1995	184.6 million	235.8 million
1996	189.3 million	242.7 million
1997	194.5 million	250.0 million
1998	199.9 million	257.5 million
1999	206.2 million	265.8 million
2000	212.4 million	274.0 million
2001	217.6 million	281.1 million
2002	222.5 million	288.1 million
2003	227.6 million	295.3 million
2004(p)	233.0 million	302.6 million

(p) - projected

Source: CPSC's **Product Population Model.**
Note: For yearly sales prior to available data, staff decreased annual sales by 3% per year.

International Trade

Historically, there has been little foreign trade in mattresses and foundations, because of the relatively high cost of shipping. Information on US international trade in mattresses shows that US imports and US exports of mattresses are similar, and that imports represent less than about 2% of total US shipments.

Retail Trends

According to industry sources, in recent years there has been a gradual shift in the preferred sizes for mattresses toward larger sized mattresses. As shown in Table 4, in the last 5 years for which data are available, the market share of mattresses in sizes larger than full rose from 40% in 1998 to 45% in 2002.

TABLE 4

Mattress Sales By Size

Type	Market Share		
	1998	2000	2002
Twin (38x74.5 in.)	29.8%	29.6%	29.1%
Twin XL (38x79.5 in.)	2.1%	2.3%	2.1%
Full (53x74.5 in.)	20.9%	20.5%	19.4%
Full XL (53x79.5 in.)	2.0%	1.7%	1.6%
Queen (60x79.5 in.)	31.6%	33.1%	34.2%
King (75x79.5 in.)	6.8%	8.6%	9.3%
California King (72x84 in.)	1.7%	1.6%	1.7%
All Other	5.1%	2.6%	2.6%

Source: **2002 U.S. Mattress Industry,** ISPA
Note: "all other" is composed of odd sizes, and conventional mattress replacements for use in lieu of waterbed bladders for use in waterbed frames.

According to the ISPA's sales statistics, the average shipment price (equivalent to the producer price) of mattresses was about $152 in 2002, up from $133 in 1999. While some of this increase may be related to inflation, it is likely that a significant share of this increase was due to the increasing share of larger mattresses in the market. The average shipment price for foundations in 2002 was $86, down from $88 in 1999. While there is some reluctance by industry to develop an "average" shipment price from mattress and foundation sets, it may be reasonable to assume that the average price for the set would be similar to the average of the 2 components: $238 in 2002 ($152+$86).

According to an independent study conducted for the ISPA, the markups from producer cost to retail price were estimated by mattress industry representatives at about four. However, recent contacts with industry representatives indicate that, with more direct-to-consumer transactions (such as Select Comfort, a major bedding manufacturer with over 300 retail stores), and direct marketing to consumers (such as television infomercials), the markup of 4 may no longer be appropriate. Further, product mix has a significant influence on markups; because of price competition from discount chains, retailers may be reluctant to charge full markups on low-end mattresses while retaining larger mark-ups on more upscale products. The ISPA's **2002**

Industry Annual Report which includes estimates of retail price points for mattress and foundation sets showed that about 41% of all bedding sets were sold at less than $500 in 2002.

A 1995 survey by **Home Furnishings Executive**, a trade publication, found that over 80% of all mattresses and foundations are purchased by women. This information has resulted in at least one major producer employing only women to select surface fabrics and types (as in pillow-top mattresses, which have been increasing in popularity in recent years). The age group (regardless of gender) that accounted for the largest share of sales was 30-44; that group accounts for almost ½ of all new bed purchases.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 29, 2004

TO : Margaret Neily, Project Manager for Mattresses

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

FROM : Soumaya M. Tohamy, Ph.D., EC ST

SUBJECT : Preliminary Regulatory Analysis of a Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses

Attached is the Preliminary Regulatory Analysis of a Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses.

Attachment

Preliminary Regulatory Analysis of a Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses*

October 29th, 2004

Soumaya M. Tohamy, Ph.D.
Directorate for Economic Analysis
U.S. Consumer Product Safety Commission

*** 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.**

Executive Summary

The U.S. Consumer Product Safety Commission received in April, 2000 a petition for rulemaking to modify the current flammability standard for mattresses to include additional ignition sources. The Commission published an Advance Notice of Proposed Rulemaking (ANPR) in October, 2001, initiating a proceeding to develop a mandatory federal standard to address open-flame ignition. This *Preliminary Regulatory Analysis* discusses the benefits and costs associated with the draft proposed standard and other options to address mattress fire safety.

The draft proposed standard will apply to all mattresses and mattress/foundation sets, produced domestically or imported. The term mattress means a ticking (i.e., an outer layer of fabric) filled with a resilient material used alone or in combination with other products intended or promoted for sleeping upon. To comply with the draft proposed standard, and have a "qualified" prototype, a manufacturer must test three mattress/foundation sets of the same prototype, and obtain passing results. All tested mattresses should meet the following criteria: (1) the peak heat release rate (PHRR) does not exceed 200 kilowatts (kW) in the first 30 minutes, and (2) the total heat release does not exceed 15 megajoules (MJ) in the first 10 minutes of the test.

Manufacturers may then sell any mattress/foundation set of the qualified prototype. Manufacturers may also sell a mattress/foundation set based on a prototype that has not been tested if that prototype differs from a qualified prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above. If pooling is conducted by the firm or establishment, one mattress/foundation set must be tested for a confirmation test by the pooling establishment or firm. Manufacturers may need to test other mattresses periodically for quality assurance testing.

Benefits of the draft proposed standard represent the reduction in deaths and injuries associated with mattress fires that are expected to result from implementation of the draft proposed standard. Using an expected mattress life of 10 years and a discount rate of 3 percent, the total lifetime benefits of a mattress that complies with the draft proposed standard are expected to range from $62 to $74 per mattress. Costs of the draft proposed standard are the increase in total resource costs (e.g. costs of material, labor, testing, and compliance efforts) that are expected to result from implementation of the draft proposed standard. The total resource costs of the draft proposed standard are expected to range from $13 to $44 per mattress, yielding net benefits (benefits minus costs) of $18 to $62 per mattress. Aggregate lifetime benefits associated with all mattresses produced the first year the standard becomes effective are expected to range from $1,560 to $1,880 million. Aggregate resource costs associated with these mattresses are expected to range from $320 to $1,110 million, yielding net benefits of about $450 to $1,560 million.

The assumptions about the expected mattress life, discount rate, effectiveness in preventing deaths and injuries, and value of life estimates were varied in a sensitivity analysis. Reasonable ranges for all these varied estimates resulted in positive net benefits of the draft proposed standard. Alternatives to the draft proposed standard were considered

including varying test criteria, testing frequency, effective dates, and taking no action. The draft proposed standard is expected to yield a positive net benefit while minimizing the impact on small manufacturers.

Table of Contents

Preliminary Regulatory Analysis of a Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses

1. Introduction

There were an estimated 18,900 fires where the first item ignited was mattress/bedding in 1998 (the last year for which detailed data comparable to previous years are available). These fires caused an estimated 2,260 civilian injuries, 410 deaths, and $255.4 million in property losses.[1] These numbers are high despite the existing federal cigarette ignition standard (codified at 16 CFR Part 1632). The cigarette ignition standard appears to have led to a reduction in mattress/bedding fires, injuries, and property loss, with no change in deaths, over the 1993-1998 period, the last six years for which comparable data are available.[2] (See Section 5 for trends in mattress/bedding fires, deaths, injuries, and property loss).

The U.S. Consumer Product Safety Commission (CPSC) received in April, 2000 a petition for rulemaking to modify the current flammability standard for mattresses to include additional ignition sources. The Commission published an Advance Notice of Proposed Rulemaking (ANPR) in October, 2001, initiating a proceeding to develop a mandatory federal standard to address open-flame ignition. This *Preliminary Regulatory Analysis* discusses the benefits and costs associated with the draft proposed standard as well as other options to address mattress fire safety.

A 1997 CPSC report (Boudreault and Smith, 1997), based on 156 mattress/bedding fires investigated by CPSC field staff between October 1994 and December 1995, concluded that bedding was the first item ignited in 67 percent of the mattress/bedding fires.[3] Bedclothes (top-of-the-bed products like mattress pads, pillows, blankets, and comforters) are most likely to be ignited first and serve as a magnifier of the initial ignition. Hence, a National Institute of Standards and Technology (NIST) study (Ohlemiller *et. al.*, 2000) designed and tested the ability of gas burners to mimic the thermal impact of burning bed clothes.

Another NIST study (Ohlemiller and Gann, 2002) indicated that the potential for flashover could be reduced if the peak heat release rate (PHRR) from a bed fire in a typical room (with other contents present) remains below 1,000 kilowatts (kW). Flashover is the point in a room fire at which radiant heat from the hot smoke accumulating in the upper portions of the room ignites all flammable materials within the room. The resultant

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[1] Smith and Mah. (2002), based on data obtained from the U.S. Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA) annual survey of fire departments.

[2] Estimated fires, deaths, injuries, and property loss displayed a decreasing trend since 1980 as documented by Smith and Mah (2002). More recent years (1993 - 1998) display a continuing decrease in estimated fires, injuries, and property loss, with no decline in estimated deaths.

[3] A similar study conducted by the National Association of State Fire Marshals (NASFM) in 1997 resulted in similar findings.

generalized burning condition leads to an abrupt transition to oxygen supply-limited combustion of the various fuel gases and a large increase in the fraction of gases turned into carbon monoxide. These hot, toxic gases leave the room and pose a very serious threat to occupants elsewhere in the building. Since the bedclothes were shown to contribute more than 400 kW in some cases, the study suggested that a mattress contributing more than 500 kW at the same time could lead to the occurrence of flashover.[4]

California Technical Bulletin (TB) 603, which is based on the use of NIST test burners designed to mimic the local thermal insult (heat flux levels and duration) imposed by burning bedclothes, is scheduled to become effective in California January 1, 2005. TB 603 requires all mattress/foundation sets, mattresses intended to be used without a foundation, and futons to meet the following pass/fail criteria: (1) the PHRR does not exceed 200 kW in the first 30 minutes, and (2) the total heat release does not exceed 25 megajoules (MJ) in the first 10 minutes of the test.

In anticipation of possible implementation of TB 603 and a possible CPSC rule, all large mattress manufacturers are expected to eventually produce TB 603-compliant mattresses for sale nationwide, because of legal liability and production logistics. In the short-run, however, some manufacturers may not produce mattresses intended for sale outside California to meet TB 603 performance requirements. Sealy's president and CEO said that "[they] plan to be ready by the end of this year [2004] if a national retailer wants the same product" with fire resistant technology, but will not convert all production by January 2005 (*Furniture Today*, March, 10, 2004). Smaller producers are more likely to wait until they have a better idea of enforcement efforts in California, or until a federal standard is adopted. The mattress industry and the International Sleep Products Association, ISPA, support the development of a mandatory federal standard (*Furniture Today*, May, 10, 2004). A Federal standard would eliminate the uncertainty that may result from having different flammability standards for different states.

2. The Draft Proposed Standard: Scope and Testing Provisions

The draft proposed standard will apply to all mattresses, where the term mattress means a ticking (i.e., an outer layer of fabric) filled with a resilient material used alone or in combination with other products intended or promoted for sleeping upon. This definition includes adult mattresses (and accompanying foundations, treated jointly as a set); youth mattresses; crib mattresses, including portable crib mattresses; bunk bed mattresses; futons; flip chairs; water beds and air mattresses which contain upholstery material between the ticking and the mattress core; and any mattresses used in items of upholstered furniture such as convertible sofa bed mattresses. It does not include sleeping bags, mattress pads, or any top of the bed articles.

A typical innerspring mattress construction might include ticking; binding tape fabric; quilt cushioning with one or more separate layers; quilt backing fabric; thread; cushioning with one or more separate layers; flanging; spring insulator pad; spring unit; and side (border) panels. Options for meeting the standard include one or a combination of fire resistant

[4] Wallboard, carpet, and other furniture in the room will contribute to the heat release critical for flashover in a typical room.

ticking, chemically treated or otherwise fire resistant filling products, or a fire blocking barrier (either a sheet style barrier, sometimes called a fabric barrier, or a high-loft barrier, sometimes called a fiber barrier). The fire blocking barrier is placed either directly between the exterior cover fabric of the product and the first layer of cushioning materials, or beneath one or more "sacrificial" layers that can burn without reaching the proposed heat release constraints.

There are already over twenty different vendors of fire resistant materials associated with the production of mattresses, including barriers, ticking, foam, tape, and thread. These materials include chemically treated cotton, rayon, and/or polyester, melamine, modacrylic, fiberglass, aramid (Kevlar®), or some combination of them. The cost of using sheet barriers is higher than using high-loft barriers, since sheet barriers are thin and therefore could not be substituted for an existing foam or cushioning layer. There is also concern that some sheet barriers, unlike high-loft barriers, may reduce the comfort of the sleeping surface.

For each qualified prototype, three mattress/foundation sets must be tested and must pass the test requirements.[5] To obtain a passing result, each mattress/foundation set must pass a 30 minute test, where the PHRR does not exceed 200 kW and the total heat release does not exceed 15 MJ in the first 10 minutes of the test.[6] A failure of any of the sets would require that a modified prototype be tested and pass the test (in triplicate). Manufacturers may sell any mattress/foundation set based on a qualified prototype. Manufacturers may also sell a mattress/foundation set based on a prototype that has not been tested if that prototype differs from a qualified prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above.

If two or more establishments (plants within the same firm) or independent firms choose to "pool" prototypes, then each polling plant or firm is required to test one mattress/foundation set for confirmation testing. If that set fails, then the plant or firm will need to test another mattress/foundation set after correcting its production to make sure that it is identical to the original prototype. A pooling firm can sell other mattresses that have not been tested by the pooling firm if they differ from the pooled (qualified) prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above.

3. Products and Industries Potentially Affected

According to the International Sleep Products Association (ISPA), the mattress producers' trade organization, the top four producers of mattresses account for almost sixty

[5] The draft proposed standard is described in more detail in Tenney (2004).

[6] This requirement is different from that of California TB 603. Tenney (2004) explains the technical reasons for this requirement.

percent of total U.S. production.[7] In total, there are 639 establishments (as of 2001) that produce mattresses in the U.S., using the U.S. Department of Commerce NAICS (North American Industry Classification System) Code 33791 for mattresses. The top four producers account for about half of the number of all these establishments. The number of establishments has been declining over time due to mergers and buy-outs. Total employment in the industry, using the NAICS Code 33791, was 25,500 workers in 2001.

The mattress manufacturing industry has three key supplying industries: spring and wire product manufacturing, broad-woven fabric mills, and foam products manufacturing. Depending on the type of fire resistant barrier chosen by different manufacturers, the demand for foam padding for mattresses might decline if it were replaced by the high-loft barrier in the construction of the mattress and foundation. This would be offset by an increase in the demand for the high-loft barrier. If sheet barriers were chosen by some mattress producers, then sales of, and employment by, the sheet barrier suppliers would increase. Since the sheet barriers would not replace other inputs, there would most likely be no offsetting effect on other industries. Fiberglass, melamine, and aramid producers may also be affected to the extent that they are used to produce fire resistant materials used in mattress production.

Manufacturers of bedclothes may also be affected by the draft proposed standard. Sales of bedclothes may increase or decrease based on whether consumers view bedclothes as complements or substitutes for a new mattress/foundation set.[8] For example, if people tend to buy all parts of a new bed (mattress, foundation, and bedclothes consisting of a comforter, pillows, and sheets) at the same time, then an increase in the quantity of mattresses sold would cause an increase in sales of bedclothes. If, alternatively, people tend to have a fixed budget for bedding items, then an increase in the quantity of mattresses sold would lead to a decrease in sales of bedclothes.[9] Also, if the decision to buy a new mattress (or mattress/foundation set) involves buying a mattress that is much thicker than the one currently in use, then consumers will most likely buy new sheets (and possibly matching pillowcases and other bedclothes items) to fit the new thicker mattress.

If the cost increase is relatively small or there is no resulting increase in the price of a mattress/foundation set, then the demand for bedclothes will only be affected if consumers place a higher value on the safer mattress and replace their current mattress sooner than they would have with no standard in place. An increased demand for the safer (and thicker, if the current mattress is relatively old) mattress will likely result in an increased demand for sheets that fit the newer mattresses. This effect, however, is not directly resulting from the adoption of the draft proposed standard since the thickness of the mattress need not be increased by the presence of either type of barrier. It is the result of the increased utility some consumers may

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[7] *Furniture Today* (May 31, 2004) estimates the market share of the top four producers to be 58.7% by value of domestic shipments in 2003. *Furniture Today* estimates the share of the top twelve producers to be 79.4%.

[8] Complements are goods that are generally consumed together, like DVDs and DVD players. In contrast, substitutes are goods that are generally substituted for one another, like VCRs and DVD players.

[9] An alternative way to analyze this is to examine what consumers would do when faced with a higher-priced mattress set. They might decide to not buy the higher-priced mattress and buy new bedclothes instead, or buy the higher-priced mattress and not buy the new bedclothes they were planning to buy.

derive from the safer mattress and the consequent increase in demand for bedclothes. The increased demand for safer mattresses would most probably lead to an increase in sales and employment in the spring and wire products, broad-woven fabric, and foam products industries, as well as in the mattress and bedclothes industries.

Other producers that could potentially be affected, if the price change associated with producing compliant mattresses is significant, are those of other substitute products, like airbeds, waterbeds, . . . etc. that contain no upholstered material and would, therefore, not be covered by the draft proposed standard. Their sales may increase as a proportion of total bedding products.

4. Characteristics of Mattresses Used in U.S. Households

The total number of U.S. conventional mattress shipments was 21.5 million in 2002 and is estimated to be 22.1 in 2003 and 22.8 in 2004. [10] Table 1 shows shipments of mattresses for the years 1981 to 2004. Mattress shipments have grown at an average rate of three percent over the period. Unconventional mattresses (including futons; crib mattresses; juvenile mattresses; sleep sofa inserts; and hybrid water mattresses) are estimated to be about ten percent of the total market (Karels, 2004). This yields an estimated total number of mattresses produced domestically of 25.3 million in 2004. The value of mattress and foundation shipments in 2002, according to ISPA, was $3.26 and $1.51 billion respectively.

The CPSC Product Population Model (PPM) estimate of the number of mattresses in use in different years is based on available annual sales data and an estimate of the average product life of a mattress. Industry representatives assert that the average consumer replaces a mattress/foundation set after ten years. A CPSC market study (Homan, 1996) estimated the average expected life of a mattress to be 14 years. The PPM estimates the number of (conventional and non-conventional) mattresses in use in 2004 to be 233 million mattresses, using a 10-year average product life, and 302.6 million mattresses, using a 14-year average product life. These two numbers are later used to estimate the pre-standard baseline risk and the expected benefits of the draft proposed standard.

This analysis focuses principally on queen-size mattresses because they are the most commonly used. In 2002 queen-size mattresses were used by 34 percent of U.S. consumers. Following the queen-size are the sizes: Twin and Twin XL (31.2 percent), Full and Full XL (21 percent), King and California King (11 percent), and all other (2.6 percent). ISPA data reflect an increasing trend of the average size of a mattress.[11] The average manufacturing price in 2002 was $152 for a mattress of average size and $86 for a foundation of average size. Hence the average manufacturing price of a mattress/foundation set was about $238 in 2002.

There are no readily available data on average retail prices for mattress/foundation sets by size. ISPA, however, reports that mattress/foundation sets selling for under $500

[10] Most of the data in this section are derived from Karels (2004) and ISPA (2004)

[11] The average size for conventional mattresses in 2002 was between the full and queen sizes, closer to the queen (ISPA).

represent 40.7 percent of the market. Mattress/foundation sets selling for between $500 and $1000 represent 39.2 percent of the market.

Table 1: Mattress Shipments*: 1981-2004

Year	Conventional		Unconventional	Total^
	Units (000s)	% change	Units (000s)	Units (000s)
2004(e)	22,793	3.0%	2,533	25,325
2003(e)	22,129	3.0%	2,459	24,587
2002	21,484	1.2%	2,387	23,871
2001	21,233	-2.0%	2,359	23,592
2000	21,675	1.5%	2,408	24,083
1999	21,345	5.9%	2,372	23,717
1998	20,164	3.5%	2,240	22,404
1997	19,487	4.4%	2,165	21,652
1996	18,671	2.5%	2,075	20,745
1995	18,220	-0.4%	2,024	20,245
1994	18,297	3.7%	2,033	20,329
1993	17,642	4.5%	1,960	19,602
1992	16,888	4.5%	1,876	18,764
1991	16,163	0.0%	1,796	17,959
1990	16,160	-1.5%	1,796	17,956
1989	16,411	-1.0%	1,823	18,234
1988	16,575	3.5%	1,842	18,417
1987	16,009	7.4%	1,779	17,787
1986	14,905	6.7%	1,656	16,561
1985	13,967	1.3%	1,552	15,518
1984	13,789	6.8%	1,532	15,322
1983	12,913	14.2%	1,435	14,348
1982	11,310	-4.7%	1,257	12,566
1981	11,867		1,319	13,186
Average		3.0%		

Source: ISPA (2004) and Karels (2004).

* Total shipments are calculated assuming that unconventional shipments (including futons; crib mattresses; juvenile mattresses; sleep sofa inserts; or hybrid water mattresses) are ten percent of the total market.

^ Numbers do not necessarily add up due to rounding.

(e) indicates estimated, based on average annual growth of three percent.

5. Trends in Mattress/Bedding Residential Fires, Deaths, Injuries, and Property Losses

Open-Flame Ignition

Smith and Mah (2002) estimate average annual mattress/bedding fires from open-flame ignitions (including candles, matches and lighters) to have been 8,367 and 6,367 over the 1993-95 and 1996-98 periods respectively.[12] This represents a reduction of 23.9 percent. (See Table 2.) The resulting average mattress/bedding deaths, injuries, and property losses from open-flame ignitions have decreased by 28.2 percent, 22.1 percent, and 5.6 percent respectively, over the 1993 to 1998 period. When adjusted for inflation, the decrease in the value of property losses becomes 37.7 percent.[13]

Smoking Material Ignition

Smith and Mah (2002) estimate average annual mattress/bedding fires from smoking material ignition (including cigarettes, cigars, and pipes) to have been 7,733 and 6,067 over the 1993-95 and 1996-98 periods respectively. (See Table 2.) This represents a reduction of 21.6 percent over the 1993 to 1998 period.[14] Average annual deaths, injuries, and property losses due to mattress/bedding smoking material ignitions have decreased by 4.7 percent, 19.7 percent, and 9.7 percent, respectively, over the same period. When adjusted for inflation, the decrease in the value of property losses becomes 40.4 percent.

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[12] Three year averages are used for all fire, death, injury, and property loss figures to ensure that the results are not biased due to using a single anomalous year as a basis for the analysis. Therefore, detailed data for 1999, though available, have not been used because they are not comparable to data from earlier years, due to a major revision of National Fire Incident Reporting System (NFIRS) data coding system that took effect with 1999 data (Miller *et. al,*. 2003). National residential fire data for the years 2000-2002, though available, lack mattress-specific detail and are not being used in this section. They are used in the economic analysis of benefits (Section 6), however, because the effectiveness data in Smith and Miller (2004) are provided for the five-year period 1998-2002.

[13] To calculate the real change over the period, Gross Domestic Product deflator figures from Bureau of Economic Analysis data are used.

[14] The declining trend of smoking material fires has been documented by Boudreault and Smith (1997). They have suggested that the reduction is at least partly caused by the 1973 (cigarette) flammability standard. They also suggested that it may be, in part, due to decreased cigarette consumption.

Table 2: Estimated Residential Structure Fires, Deaths, and Injuries 1993-1998.
Mattress, Bedding Non-Incendiary and Non-Suspicious Only

	1993	1994	1995	1996	1997	1998	1993-95 Avg.	1996-98 Avg.	% Chg.	% Ch. Cst$*
Fires										
Open-Flame Ignition	8800	9100	7200	6900	6200	6000	8367	6367	-23.9	
Smoking Material Ignition	8500	7800	6900	6700	5700	5800	7733	6067	-21.6	
Other	9100	8600	8200	8100	8100	7100	8633	7767	-10.0	
Total	**26300**	**25500**	**22200**	**21700**	**20000**	**18900**	**24667**	**20200**	**-18.1**	
Deaths										
Open-Flame Ignition	150	150	90	100	100	80	130	93	-28.2	
Smoking Material Ignition	350	230	270	330	230	250	283	270	-4.7	
Other	80	90	120	230	130	80	97	147	51.7	
Total	**580**	**470**	**480**	**660**	**460**	**410**	**510**	**510**	**0.0**	
Injuries										
Open-Flame Ignition	1320	1300	1130	1030	910	980	1250	973	-22.1	
Smoking Material Ignition	1070	870	750	750	720	690	897	720	-19.7	
Other	830	660	610	630	580	600	700	603	-13.8	
Total	**3220**	**2820**	**2490**	**2400**	**2210**	**2260**	**2843**	**2290**	**-19.5**	
Property Losses (measured in million $)										
Open-Flame Ignition	102.2	105.3	104.9	108.9	97.1	89.0	104	98	-5.6	-37.7
Smoking Material Ignition	93.6	70.3	75.2	72.7	73.4	69.8	80	72	-9.7	-40.4
Other	139.2	109.0	107.2	105.2	128.3	96.6	118	110	-7.1	-38.7
Total	**335.0**	**284.7**	**287.3**	**286.8**	**298.9**	**255.4**	**302**	**280**	**-7.3**	**-38.83**

Source: U.S. Consumer Product Safety Commission/EPHA, from data obtained from the U.S. Fire Administration and NFPA. Last four columns are calculated.

* Constant dollar percent changes are derived using Bureau of Analysis GDP deflator estimates.

Notes: Estimates exclude losses from incendiary and suspicious fires.
Fire estimates are rounded to the nearest 100. Death and injury estimates are rounded to the nearest 10.
Property loss estimates, not adjusted for inflation, are rounded to the nearest tenth of a million.
Due to rounding, subtotals do not necessarily add up to heading totals and percentage changes may not reflect the rounded numbers in the table.

Other Ignition Sources

Smith and Mah (2002) estimate average annual mattress/bedding fires from other ignition sources (including sparks, embers, or flames escaping from fueled equipment, arcs or sparks from electric equipment, small torches, hot embers, and fireworks, heat escaping from fueled equipment, molten material, short circuit arc, and heat overloaded equipment) to have been 8,633 and 7,767 over the 1993-95 and 1996-98 periods respectively. (See Table 2.) This represents a reduction of 10 percent over the 1993 to 1998 period. Average annual injuries and inflation-adjusted property losses have decreased by 13.8 percent and 38.7 percent respectively. Average annual deaths increased by 51.7 percent (from 97 to 147). This increase offsets the decrease in deaths resulting from open-flame and smoking material ignition fires. The annual average number of deaths from all ignition sources remained unchanged over the period, equal to 510.

Expected benefits from the draft proposed standard, measured in terms of saved lives and reduced injuries are summarized in the next section. (See Smith and Miller, 2004 for a more detailed measure). These benefits are then used to calculate expected first-year monetary benefits associated with a mattress/foundation set produced in 2004 and project expected lifetime benefits for the set. Expected lifetime benefits are compared to costs in Section 8.

6. Expected Benefits of the Draft Proposed Standard

The expected benefits of the draft proposed standard are estimated as reductions in the baseline risk of death and injury from all mattress fires, based on a study of fire investigations from 1999-2004 by Smith and Miller (2004). Risk reductions are then calculated on a per-mattress-in-use basis based on estimates of the number of mattresses in use. The monetary value of expected benefits per mattress is derived using current (i.e., 2004) estimates for the value of a statistical life and the average cost of a mattress fire injury. To derive the monetary value of expected benefits over the life of a mattress, the expected annual benefits are discounted (using a three percent discount rate), and then summed over the expected life of the mattress. The analysis considers mattress lives of 10 and 14 years.

The potential benefits of the draft proposed standard consist of the reduction in deaths, injuries, and property damage that would result. Since the objective of the draft proposed standard is to reduce the likelihood of flashover or increase the time before flashover occurs, and not to reduce fires, changes in property losses associated with the draft proposed standard are hard to quantify. [15] Property losses are expected to decline but the extent of the decline cannot be quantified (Smith and Miller, 2004). Consequently, for purposes of this analysis, no reduction in property losses is assumed. That is, all expected benefits from the draft proposed standard are in the form of prevented deaths and injuries. It

[15] The reduction in property losses may be very large or small. A large reduction would occur if reducing the likelihood of flashover restricts the damage to the room of origin and does not spread to other rooms in the residence. Conversely, the reduction in property losses would be small in some cases, if most of the damage is water damage from the use of sprinklers and is therefore not affected by the size of the fire. This reduction could also be small if fire department response time is long.

should be clear that this underestimates net benefits, since there will likely be some benefits from reduced property losses.

The draft proposed standard is expected to reduce the likelihood of flashover resulting from fires started by smoking materials or other ignition sources, as well as those started by open-flame ignition. As shown in Table 2, fires, injuries, and property losses resulting from smoking material ignition and other ignitions, and deaths from smoking material ignition are lower for the 1996-98 period than the 1993-95 period. (Deaths from other ignition sources are more than 50 percent higher). Any additional reduction in these figures due to the draft proposed open-flame ignition standard will translate into societal benefits, as will be discussed in the benefit-cost analysis (Section 8).

Estimates of the effectiveness of the draft proposed standard are based on a CPSC staff evaluation of in-depth investigation reports of fires (including details of the occupants' situations and actions during the fire) occurring in 1999-2004 in which a mattress or bedding was the first item to ignite, the fire was of the type considered addressable by the draft proposed standard, and a civilian death or injury resulted.[16] Most of the investigations also included documentation from the fire department that attended the fire. Some incident reports were initiated from death certificates with follow-up documentation from the fire department. This resulted in a total of 195 deaths and 205 injuries in the investigations to be evaluated. The distribution of mattress ignition sources was not representative of all fires involving mattresses and thus the data were weighted to match the NFIRS-based national fire data distributions.

Evaluations of the fire incidents by CPSC staff reviewers used the results of NIST testing (Ohlemiller, 2004; Ohlemiller and Gann, 2003; Ohlemiller and Gann, 2002) conducted to assess the hazard produced from burning mattresses and bedclothes. Specifically, the evaluations were based on the expectation that occupants in bed when the fire ignited but able to escape the burning bedclothes in the first three to five minutes faced a minimal hazard. Occupants in direct contact with burning bedclothes for a longer period (5 to 10 minutes) would be subject to potentially hazardous levels of heat release. If the burning bedclothes did not ignite other non-bedding items or produce flashover at this time, heat release would subside temporarily and then begin to increase as the involvement of the mattress increased.

These conditions would allow occupants 10 to 15 minutes to escape the room of origin before the situation in the room would become untenable (Tenney, 2004). Since the draft proposed standard is expected to slow the rate of fire spread and thus increase escape time, assuming that bedclothes do not contribute enough heat to pose a hazardous condition, it was assumed that no deaths would occur among people who were outside the room of origin at the time of ignition, unless they entered the room later or were incapable of exiting on their own (Smith and Miller, 2004). The analysis focused on reduction of deaths and injuries because the draft proposed standard is designed to limit fire intensity and spread rather than prevent ignition.

[16] Smith and Miller (2004) detail the methodology for deriving the effectiveness of the draft proposed standard.

Each investigation was evaluated by CPSC staff reviewers to identify the features related to the occurrence of a death or injury once the fire was ignited. These included casualty age, casualty location when the fire started (at the point of ignition, in the room of origin but not at the point of ignition, or outside the room of origin), whether the casualty was asleep, or suffered from additional conditions likely to increase the time needed to escape, whether the casualty engaged in fighting the fire, and whether a rescuer was present. All of these conditions were used to determine a range for the likelihood that each individual death or injury would have been prevented had the draft proposed standard been in effect. Percentage reductions of deaths (injuries) within subcategories of heat source and age group were applied to equivalent sub-categories of the national estimates based on the NFPA data for 1995 to 1999. The estimated reductions per category were summed and the overall percentage reductions were calculated as the percent of addressable deaths (or injuries) that would have been prevented if the likelihood of flashover were reduced in the first 30 minutes and victims had 10 to 15 minutes of escape time (Smith and Miller, 2004).

Table 3 presents the estimated effectiveness of the draft proposed standard, based on applying the effectiveness estimates, derived from 1999-2004 investigations, to 1998-2002 residential fire data (Smith and Miller, 2004). It indicates that the draft proposed standard is expected to reduce all addressable deaths from mattress/bedding fires by 80 to 86 percent and reduce all addressable injuries from mattress/bedding fires by 86 to 92 percent. The results vary only slightly by source of ignition. These estimated effectiveness percentages result in the prevention of an estimated 310 to 330 deaths and 1660 to 1780 injuries annually, for the 1998-2002 period (Smith and Miller, 2004).

Table 3: Estimated Effectiveness of the Draft Proposed Standard.

Ignition Source	Percent Reduction in Deaths	Percent Reduction in Injuries
Open-Flame Ignition	83 - 89	86 - 92
Smoking Material Ignition	74 - 80	87 - 92
Other Material Ignition	81 - 87	85 - 92
Total	**80 - 86**	**86 - 92**

Source: Smith and Miller (2004).

Table 4 presents the estimated annual deaths and injuries that are expected to be prevented by the draft proposed standard, based on average figures for 1998-2002. For purposes of this analysis, it is assumed that the annual deaths and injuries prevented by the draft proposed standard equal the average annual deaths and injuries prevented for the 1998-2002 period. The analysis will be conducted as if the standard went into effect in 2004. All dollar estimates are based on constant 2004 dollars. A discount rate of 3 percent and average expected lives of a mattress of 10 and 14 years are also assumed.

Table 4: Estimated Benefits of the Draft Proposed Standard

	Mattress Life	
	10 years	**14 years**
Deaths		
Annual Deaths Prevented*	310 - 330	310 - 330
First-Year # of Mattresses in Use (mill.)	233.0	302.6
First-Year Risk Reduction (per mill. mattresses)	1.33 - 1.42	1.02 - 1.09
First-Year Benefits per Mattress	$6.65 - $7.08	$5.12 - $5.45
Lifetime Benefits per Mattress	$51.72 - $62.22	$50.23 - $63.44
Injuries		
Annual Injuries Prevented*	1660 - 1780	1660 - 1780
First-Year Risk Reduction (per mill. mattresses)	7.12 - 7.64	5.49 - 5.88
First-Year Benefits per Mattress	$1.28 - $1.37	$0.98 - $1.05
Lifetime Benefits per Mattress	$9.93 - $12.03	$9.65 - $12.27
Total		
First-Year Benefits per Mattress	$7.93 - $8.45	$6.11 - $6.51
Lifetime Benefits per Mattress	$61.66 - $74.25	$59.88 - $75.71

* Smith and Miller (2004).

Notes: - Risk reduction is calculated as the number of casualties prevented (1998-2002 average), multiplied by a million, divided by the estimated number of mattresses in use in the first year.
- Numbers may not add up due to rounding.
- First-year benefits per mattress are measured in 2004 dollars. Lifetime benefits are based on the sum of the annual discounted benefits (measured in 2004 dollars, and discounted at a rate of three percent) over the expected life of the mattress.

The estimated ranges of deaths and injuries prevented, as presented in Table 4, are calculated by applying the range of percent reductions from Table 3 to average addressable deaths and injuries for the period 1998-2002 (Smith and Miller, 2004).[17] Table 4 also presents the risk reduction in deaths and injuries that would result from the draft proposed standard (per million mattresses).[18] Based on the estimated number of mattresses in use (described in Section 4), the annual reduction in the risk of death equals 1.33 deaths per million mattresses (310 deaths divided by the estimated 233 million mattresses in use in 2004) to 1.42 per million mattresses (330 deaths / 233 million mattresses). The estimated reduction in the risk of injury, similarly calculated, equals 7.12 to 7.64 injuries per million mattresses for an estimated 10-year life of a mattress. The estimated risk reductions for an

[17] Annual addressable deaths and injuries associated with mattress fires are estimated for the period 1998-2002 as 100 percent of total mattress/bedding deaths and 97 percent of total mattress/bedding injuries respectively (Smith and Miller, 2004).

[18] The risk of death and injury is lower for 2004 (compared to the average annual risk for 1998-2002) because the number of deaths and injuries is divided by the estimated number of mattresses in use, which (from Table 2) was assumed to grow from 2002 to 2004 at an annual rate of three percent.

estimated 14-year life of a mattress are 1.02 to 1.09 deaths and 5.49 to 5.88 injuries per million mattresses.

Annual risk reductions resulting from the draft proposed standard are used to derive the monetary benefits from reduced deaths and injuries. The estimated reduction in the risk of death is multiplied by the value of a statistical life (and divided by a million) to derive a first-year monetary estimate for the range of benefits from lives saved per mattress. Based on the existing literature, a value of a statistical life of five million dollars is assumed (Viscusi, 1993). The estimated reduction in the risk of injury is similarly used to derive the range of first-year monetary benefits from injuries prevented.[19] The benefits from preventing an injury (the cost of an injury) in 2004 are estimated to average about $179,300, based on Miller *et. al.* (1993). The first-year benefits associated with preventing deaths and injuries equal $7.93 to $8.45 for an estimated mattress life of 10 years and $6.11 to $6.51 for an estimated mattress life of 14 years.[20] (See Table 4.)

Lifetime benefits are derived by projecting annual benefits for the life of the mattress and summing the discounted (at a rate of 3 percent) stream of annual benefits (measured in constant dollars).[21] The number of mattresses in use is projected to grow at a rate of zero to three percent, based on the average growth rate for the 1981-2002 period. Since the number of deaths and injuries are implicitly assumed to remain constant over time, a positive growth rate of mattresses in use implies a declining risk over time. The lower end of the ranges for estimated (10 and 14 years) lifetime benefits in Table 4 correspond to a 3 percent projected growth rate and the lower end of the effectiveness ranges in Table 3. The upper end of the ranges for estimated (10 and 14 years) lifetime benefits in Table 4 correspond to a zero percent projected growth rate and the upper end of the effectiveness ranges in Table 3. For an expected mattress life of 10 years, the resulting expected lifetime benefits of saved lives associated with the draft proposed standard equal $51.70 to $62.22 per mattress. The corresponding benefits of prevented injuries equal $9.93 to $12.03. Hence, for an expected mattress life of 10 years, the expected total lifetime benefits of a compliant mattress equal $61.66 to $74.25. For an expected mattress life of 14 years, total benefits equal $59.88 to

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[19] The estimate consists of medical costs including transport costs, productivity lost, reduced quality of life (including what is commonly referred to as "pain and suffering"), and legal and health insurance administrative costs for fire-related injuries. Data from the National Electronic Injury Surveillance System (NEISS) from 01/01/95 to 09/30/04 on medical disposition (admitted or treated and released) and NFIRS/NFPA residential fire statistics are combined to arrive at this estimate.

[20] The estimated life of a mattress affects the estimated benefits in two ways. First, because the estimated number of mattresses in use increases with the estimated life of the mattress, the annual benefit per mattress is smaller for a longer mattress life. Second, the longer the life, the more years consumers derive benefits from the same mattress. These two offsetting effects make the net change very small, as indicated by comparing the lifetime (10 and 14 years) values per mattress, in Table 4.

[21] This calculation assumes that the casualties of a fire will be the same for all years of the mattress life. While deaths from smoking and open-flame ignition mattress fires are decreasing, deaths from mattress fires due to other ignition sources are increasing. These two factors will likely offset each other, making this assumption not unreasonable for death casualties. Injury casualties, however, will probably decline over the lifetime of the mattress. Because reduced deaths contribute a much larger share to overall benefits, the decline in injuries is ignored in this section. The sensitivity analysis shows positive net benefits of the draft proposed standard even if injuries were not affected and only deaths were reduced.

$75.71 per mattress. The sensitivity analysis section below examines how the results might change when a discount rate of seven percent is used. These estimates appear in the benefits summary in Table 5, Section 8.

7. Expected Costs of the Draft Proposed Standard

This section presents the expected resource costs associated with the draft proposed standard. Resource costs are costs that reflect the use of a resource that would have been available for other uses had it not been used in conjunction with the production of mattresses compliant with the draft proposed standard. These costs include material and labor costs; testing costs; costs to wholesalers, distributors, and retailers; costs of producers' information collection and record keeping; costs of quality control/quality assurance programs; and compliance and enforcement costs. The effect on retail prices will be discussed in Section 8.

Material and Labor Costs

To comply with the draft proposed standard, the construction of most mattress/foundation sets will include a barrier technology with improved fire performance. This barrier may be thick (high-loft) or thin (sheet). High-loft barriers are generally used to replace some of the existing non-woven fiber, foam, and/or batting material, leading to a smaller increase in costs than sheet barriers, which constitute an addition to production materials (and costs).

According to several barrier producers and mattress manufacturers, the price of a high-loft barrier that would make a mattress comply with the draft proposed standard is $3.00 to $5.00 per linear yard, defined to have a width of 88 to 92 inches.[22] The high-loft barrier replaces the currently-used polyester batting, which costs an average of $0.50 to $1.70 per linear yard. Hence, the net increase in the cost attributed to the use of the high-loft barrier is $1.30 to $4.50 per linear yard, which translates to a net increase in barrier-related manufacturing costs of $7.80 to $27.00 for a queen-size mattress/foundation set.[23] The queen-size is used for all the cost estimates, because it is the mode size, used by 34 percent of consumers in 2002.[24]

According to several barrier producers and mattress manufacturers, the price of a sheet barrier that would make a mattress comply with the draft proposed standard is $4.00 to $6.00 per linear yard. Because of its different texture, the sheet barrier would generally not

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[22] The actual lower end of this range is likely to be a bit lower because of quantity discounts offered by input suppliers to large mattress producers. These quantity discounts are offered to reward manufacturers for committing to a large daily volume and long contract durations.

[23] This calculation is based on the assumption that a queen-size mattress/foundation set requires six linear yards of the barrier material to be used in the two (top and bottom) panels of the mattress and the side panels of both the mattress and foundation. Some producers are able to use less than six linear yards, which reduces their cost per queen mattress/foundation set.

[24] The median size is the full size and the average size is between the full and queen sizes. This implies that the benefit-cost analysis may underestimate net benefits, because benefits are estimated for all mattresses while cost estimates focus on queen size mattresses.

replace any of the materials being used in the construction of the mattress/foundation set.[25] This translates to $24.00 to $36.00 for a queen-size mattress/foundation set. The large difference in the net cost of the two barrier types suggests that if a barrier's fire performance is not a function of its type, most manufacturers will use high-loft barriers, the less costly alternative. A large mattress manufacturer also indicated that mattresses produced with sheet barriers in the top panel of the mattress (as opposed to the side panels) may be less comfortable.

In addition to the increase in material costs due to the use of a barrier, costs will increase due to the use of fire-resistant (FR) thread for tape stitching. According to several thread producers, the cost of FR thread is $0.41 to $0.60 per queen-size mattress/foundation set. Given that the cost of nylon (non-FR) thread is about $0.10 per queen-size mattress/foundation set, the net increase in costs per queen-size mattress/foundation set due to the use of FR thread is $0.31 to $0.50.

Costs may also increase due to slightly reduced labor productivity. Based on industry estimates of an average of two labor hours for the production of a queen-size mattress/foundation set, and a 10 percent reduction in labor productivity and an industry average hourly wage rate of $11.50, the cost increase due to reduced labor productivity is about $2.30.

The increase in the materials and labor costs of a mattress, is thus equal to $10.41 ($7.80 barrier cost + $0.31 thread cost + $2.30 labor cost) to $29.80 ($27 barrier cost + $0.50 thread cost + $2.30 labor cost) for a high-loft barrier and $26.61 ($24.00 barrier cost + $0.31 thread cost + $2.30 labor cost) to $38.80 ($36 barrier cost + $0.50 thread cost + $2.30 additional labor cost) for a sheet barrier.[26] Various types of high-loft and sheet barriers are widely available for sale and therefore it is expected that those whose prices are at the upper end of the range will either not be produced (because mattress manufacturers will not buy them) or their prices will drop (so that they can compete with other barriers available for sale). Hence the total materials and labor costs will most likely be closer to the lower end of the estimated range.

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[25] The only exception to this might involve using a sheet barrier in the side panel of the mattress and foundation. Because the existence of cushioning along the side of the mattress and foundation would probably not be noticed or missed by consumers, substitution of the sheet barrier for the material currently being used in the side panel may be implemented to reduce the cost of using the sheet barrier. The side panel is small, relative to the size of the entire surface area of a mattress/foundation set, and its possibly different construction is therefore not included in the cost calculation. This leads to a slight over-estimation of the cost of the sheet barrier and consequently the relative cost of using a sheet instead of a high-loft barrier.

[26] Some producers are also using an FR mattress edge binding tape, which costs an average of $2.52 per mattress, while a non-FR tape costs an average of $1.68. This makes the net increase in costs, due to using FR edge binding tape, equal to $0.84. This cost is not added to the total production costs, because it is not required for the mattress to pass the burn test.

Costs of Prototype and Confirmation Testing

Each mattress/foundation set qualified prototype is required to be tested in triplicate for prototype qualification.[27] According to industry representatives, the cost of testing per twin-size mattress/foundation set may be about $500: the sum of the average cost of the materials and shipping ($100) and the cost of the use of the lab ($400).[28] Hence, the cost of testing three mattress/foundation sets for a prototype qualification equals $1500.[29] Additionally, if some mattress/foundation prototypes do not pass the first time, then the cost will be higher, because additional tests will be done after action is taken to improve the resistance of the prototype. If 10 percent of mattresses are retested, then the average cost of testing a prototype would be 10 percent higher, or $1650. This cost is assumed to be incurred no more than once per establishment for each qualified prototype. It is expected that a qualified prototype will be used to represent a mattress construction (e.g., single-sided pillow top, double-sided pillow-top, tight-top, euro-top, . . . etc.) with all other prototypes using the same construction (with different sizes and different ticking materials) being based on the qualified prototype.

If companies pool their prototypes across different establishments or different companies, testing costs would be smaller as all but one of the firms/establishments producing to the specification of a pooled prototype will burn one mattress (for the confirmation test) instead of three (for the prototype test). The probability of a mattress failing a confirmation test is small. Therefore, it is expected that the average cost of testing per mattress will be lower for firms and/or establishments that pool their results than for those that do not.

If manufacturers test every mattress/foundation construction (e.g., single-sided pillow top, double-sided pillow-top, tight-top, euro-top, . . . etc.), which is estimated, based on conversations with manufacturers, to average about twenty per manufacturer, for every establishment in a given year, then their average testing cost per mattress would approximately equal 92.5 cents ($1650* 20 constructions * 639 establishments / 22.8 million conventional mattresses) per mattress/foundation set for the first year of production. If manufacturers use a qualified prototype of the least fire-resistant mattress/foundation construction to represent other mattress/foundation constructions, then the average cost of testing per mattress/foundation set for the first year of production will be reduced. Pooling testing results across establishments and/or firms will further reduce the average cost of testing per mattress/foundation set. On an annual basis testing costs will be further reduced because prototypes need not be tested every year.

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[27] A prototype is defined as a specific design of mattress and corresponding foundation, if any, which serves as a model for production units intended to be introduced into commerce. (See Sec. 1633.2(k) of the draft proposed standard.) This definition implies that any change to the size, ticking, and/or any other component of the mattress/foundation set assembly results in a different prototype.

[28] The draft proposed standard requires testing of mattress/foundation sets that are no smaller than a twin size, unless the largest size mattress/foundation set is smaller than in twin set, in which case the largest size must be tested. Given the lower cost of the twin mattresses and the availability of more laboratories that are equipped to test twin mattresses, it is expected that most manufacturers will only test twin size mattresses.

[29] As more laboratories are being built, either by mattress manufacturers to test their own production or private laboratories, this cost is expected to decline.

Cost of Information Collection and Record Keeping

In addition to prototype testing, the draft proposed standard will require detailed documentation of all tests performed and their results including video or pictures; prototype or production identification number; date and time of test; and name and location of testing facility; test room conditions; and test data for as long as the prototype is in production and for three years after its production ceases. Manufacturers are also required to keep records of a unique identification number for the qualified prototype and a list of the unique identification numbers of each prototype based on the qualified prototype and a description of the materials substituted and/or the size change. Moreover, they are required to document the name and supplier of each material used in construction of a prototype and keep physical samples of the material. Additionally, they are required to identify the details of the application of any fire retardant treatments and/or inherently fire resistant fibers employed relative to mattress components.

This documentation is in addition to documentation already conducted by mattress manufacturers in their efforts to meet the cigarette standard. Detailed testing documentation will be done by the test lab and is included in the estimated cost of testing. Based on CPSC Office of Compliance staff estimates, all requirements of the draft proposed standard are expected to cost an establishment about 110 minutes, or 1.3 hours, per qualified prototype. Assuming that every establishment will produce 20 different qualified prototypes, the increase in record keeping costs is about $935 (110 minutes * 20 qualified prototypes * $25.50 in average civilian workers' compensation per hour) per establishment per year. (Note that pooling among establishments or using a qualified prototype for longer than one year will reduce this estimate.) This translates to an average cost of 2.6 cents per mattress for an average establishment, with average output of 35,681 conventional mattresses.

Cost of Quality Control/Quality Assurance Programs

To ensure that all mattresses are produced to the prototype specification across all factories and over the years for which a production line exists, mattress manufacturers will need a thorough well-documented quality control/assurance program. The top 12 mattress producers (with a market share of almost 80 percent) have an existing quality control program which could be modified to fit the new standard with minimal additional costs. Smaller producers, whose quality control program is less detailed or non-existent, will incur some incremental costs as a result of the draft proposed standard. These incremental costs will be small for each manufacturer and less when measured per mattress. (See the section on impact of the draft proposed standard on small businesses for a description of their cost of quality control and quality assurance programs.)

Additionally, the standard encourages random production testing to assure manufacturers that their mattresses continue to meet the requirements of the rule, as a possible component of the quality control/quality assurance program. Assuming that an average of 3 mattress/foundation constructions will be tested per establishment per year yields an estimated cost of production testing of about $1500. Based on this assumption, the

estimated cost of testing mattress/foundation sets for quality assurance purposes, therefore, equals 4.2 cents per mattress ($1500 / 35,681) for an average establishment.[30]

The labor needed to meet the quality assurance measures required by the standard is estimated by CPSC Office of Compliance staff to be 224 minutes per qualified prototype per year. Assuming that every establishment will produce 20 qualified prototypes, the increase in labor costs associated with quality assurance requirements of the draft proposed standard is about $1904 (224 minutes * 20 qualified prototypes * $25.50 average civilian workers' compensation per hour) per qualified prototype per year. (Note that pooling among establishments, which would reduce the number of original prototypes per establishment, or using a qualified prototype for longer than one year will reduce this estimate.) This yields an average cost of 5.3 cents per mattress for an average establishment, with average output of 35,681 mattresses. Hence expected total costs of quality assurance/quality control programs may average about 9.5 cents (4.2 + 5.3) per conventional mattress per year.

Costs to Wholesalers, Distributors, and Retailers

An added cost of the draft proposed standard is the increase in costs to wholesalers, distributors, and retailers in the form of additional storage, transportation, and inventory financing costs. Since a mattress complying with the draft proposed standard will not be bigger than a similar mattress produced before the standard becomes effective, storage and transportation costs are not expected to increase.[31] Inventory financing costs will increase by the average cost of borrowing money, applied to the wholesale price of a mattress over the average inventory holding time period. Since most mattress producers use just-in-time production and have small inventories, this additional cost will probably not exceed ten percent of the increase in production cost (which is the sum of material, labor, testing, record keeping, and quality assurance costs). A ten percent mark-up is, therefore, being used to measure the cost to wholesalers, distributors, and retailers.[32] This yields a resource cost to wholesalers, distributors, and retailers equal to $1.15 to $3.98 per mattress/foundation set. Retail prices may increase by more than the ten percent mark-up. Section 8 discusses the impact of the draft proposed standard on retail prices of mattresses.

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[30] A thread manufacturer is marketing a barrier quality control program to mattress manufacturers that would cost less than $5000 per establishment. This translates to an average cost of 14 cents per mattress for an average establishment, with average output per establishment equal to 35,681. This program is an option for manufacturers who lack any quality control/assurance program. All other mattress producers would be expected to have a lower cost per establishment.

[31] If a sheet barrier is used in addition to all other material, the mattress/foundation set will be slightly heavier, but the additional weight will be insignificant compared to the weight of the set and will probably not result in additional shipping costs.

[32] The remaining part of the cost-to-retail-price markup (estimated by mattress manufacturers to be about four-fold) is not a reflection of an increase in costs specific to the introduction of the draft proposed standard. It is a mere transfer from consumers to manufacturers, wholesalers, distributors, and retailers and does not reflect any additional resource costs to society. Refer to Office of Management and Budget, 1996 for a discussion of the proper treatment of transfer payments in regulatory analysis.

Costs of Compliance and Enforcement

Compliance and enforcement costs refer to the costs incurred by CPSC to ensure that manufacturers are complying with the draft proposed standard. Based on the past experience with the mattress cigarette ignition standard, the estimated CPSC inspection time spent per location (establishment) equals 33 hours for inspection and 6 hours for sample collection. This yields a cost per inspection of about $1,664.52 (39 hours * $42.68, the average wage rate for CPSC inspectors). Additionally, compliance officers spend an average of 20 hours per case, making their cost equal to $1,032.80 (20 hours * $51.64, the average hourly wage rate for compliance officers). This yields an average compliance and enforcement total labor cost of $2,697.32 per inspected establishment per year.

It should be noted that the *expected* cost per establishment, if less than one hundred percent of establishments are inspected every year, equals the cost per inspected establishment times the probability that a given establishment will be inspected. Though the probability that a given establishment will be inspected in a given year is not known, assuming that a third of all establishments will be inspected (i.e., about 213 establishments) yields a compliance and enforcement total expected labor cost of $899.11 ($2697.32 * (1/3)) per establishment per year.

In addition to labor costs, CPSC will incur testing costs. It should be noted that the decision to collect samples after an inspection visit is made at the discretion of the investigator and, therefore an accurate assumption about the number of samples collected and sent for a burn test cannot be made. If, based on inspection, samples from 10 percent of all inspected establishments were to be collected and sent to a lab for a burn test, and if samples representing 5 qualified prototypes are taken from each of these establishments, then the total cost of CPSC testing will be $157,500 (5 qualified prototypes * $1,500 (the cost of testing 3 mattresses for each qualified prototype) * 21 (10 percent of 213 inspected establishments)). These assumptions about frequency of testing yield an expected cost of testing per establishment of $246.48 ($157,500 / 639).

Therefore the expected total CPSC wage and testing costs associated with the draft proposed standard per establishment per year equal $1,145.59 ($899.11 + $246.48). With an average production of 35,681 mattresses per establishment (22.8 million mattresses divided by 639 establishments), the average CPSC wage and testing costs equal 3.2 cents per mattress ($1,145.59 / 35,681). These costs are expected to decrease over time as manufacturers learn the requirements of the draft proposed standard and become more likely to comply with these requirements.

Total Resource Costs

Therefore expected total resource costs (including material costs, labor costs, costs of prototype and confirmation testing, paperwork collection and record keeping costs, costs of quality control/quality assurance programs, production testing costs, costs to wholesalers, distributors, and retailers, and costs of compliance and enforcement) are estimated to range from $12.63 to $43.86 per mattress. This range includes both the high-loft and sheet barriers. The section on the impact of the draft proposed standard on small businesses and other small entities discusses how costs of testing and quality control/quality assurance programs may differ for small businesses and strategies that small manufacturers might adopt to reduce these costs.

Projected Future Costs

It is possible that costs associated with the standard will decline over time. A supplier of fire resistant barriers predicts that the price of the barriers will decline by 40 percent in the next two years, due to decreased uncertainty and increased competition. (They have already dropped significantly since TB603 was proposed.) The increase in labor costs due to decreased productivity is expected to be temporary and be reduced when workers get more training and/or the older machines get replaced with newer machines that are more capable of handling the FR thread and material used in fire resistant barriers. Moreover, as noted above, prototype testing costs are expected to decline after the first year of the standard.

The draft proposed standard references an effective date of twelve months following publication of a final rule. The costs reported here are based on the assumption that supplier companies will be able to maintain existing capacity. If federal standards for bedclothes and upholstered furniture were mandated at the same time and input producers were not given enough time to increase their capacity, input prices would rise in the short-run because of increased demand for the FR material used by all three industries.

Unquantifiable Costs

A mattress manufacturer indicated that in response to an FR mattress standard, the number of models/styles produced may be cut by half. If this response is typical, then there may be a reduction in consumers' utility, because of the reduction in mattress types that they would have to choose from. Others indicate that there will be an aversion to producing double-sided mattresses, because it would be harder for them to pass the burn test. Double-sided mattresses possibly have a longer expected life than single-sided ones. To the extent that consumers prefer double-sided mattresses to single-sided mattresses, the shift away from producing double-sided mattresses imposes a non-monetary cost. Though unquantifiable, this reduction in choices of construction type and design is an added cost to consumers of the draft proposed standard.

Another unquantifiable cost is the possible increase in liability insurance faced by mattress manufacturers. Because the draft proposed standard measures the performance of the entire mattress when exposed to fire, and not its individual components, liability will be shared by input suppliers and mattress manufacturers. Industry representatives expect that manufacturers' liability insurance will increase to reflect the additional possibility of litigation. This increase, however, cannot be quantified because of the novelty of this performance test. Compliance of more mattress firms with the California TB 603 standard may enable us to estimate the additional liability insurance. Notice that any increase in liability insurance faced by FR input suppliers will be included in the price charged for the FR inputs and does not add to the total increase in resource cost that is expected to result from the draft proposed standard.

8. Benefits and Costs of the Draft Proposed Standard

This section compares benefits and costs of the draft proposed standard, presents a sensitivity analysis, and highlights the impact of the draft proposed standard on retail prices, small businesses, children, and the environment. The sensitivity analysis examines the effect

of changing some of the assumptions used earlier. The analysis shows that net benefits continue to be positive under a reasonable range of assumptions about the death and injury effectiveness of the draft proposed standard, the reduction in injuries resulting from the draft proposed standard, the value of a statistical life estimate, the discount rate, or the expected mattress life.

Table 5 shows that the expected aggregate lifetime benefits associated with one year's production of mattresses (25.3 million units) and using a discount rate of three percent and an expected 10-year mattress life are $1.56 to $1.88 billion ($61.66 to $74.25 per mattress * 25.3 million mattresses). The corresponding expected aggregate costs of the draft proposed standard are $0.32 to $1.11 billion ($12.63 to $43.86 times 25.3 million). The resulting net aggregate benefits equal $0.45 to $1.56 billion ($17.79 to $61.62 times 25.3 million). For a mattress life of 14 years (and a 3 percent discount rate), aggregate lifetime benefits, costs, and net benefits of the draft proposed standard associated with one year of production are $1.52 to $1.92, $0.32 to $1.11, and $0.41 to $1.60 billion respectively. The expected benefits of the draft proposed standard will accrue for a long period of time and discounted net benefits will, therefore, be much greater than net benefits associated with only the mattress production in the first year the standard becomes effective.

Sensitivity Analysis

The previous analysis compares benefits and costs of the draft proposed standard using expected mattress lives of 10 and 14 years, a discount rate of 3 percent, an expected effectiveness rate of the draft proposed standard of 80 to 86 percent of deaths and 86 to 92 percent of injuries, an estimated value of a statistical life of 5 million dollars, and an estimated cost of injury of $179,300. This section examines the effect of changing any of these assumptions on the expected net benefits of the draft proposed standard.

Comparing expected benefits and costs of the draft proposed standard (as indicated in Table 5), it is clear that net benefits are expected to be positive (i.e., expected total benefits exceed expected costs) for an average mattress life of 10 or 14 years. Though increasing the expected mattress life from 10 to 14 years, while using the 3 percent discount rate, expands the positive range of net benefits, it does not affect the conclusion regarding net benefits. A further increase of the expected life of a mattress similarly would not affect the estimate of net benefits. For example, using the Product Population Model estimate of the number of mattresses in use based on an expected mattress life of 18 years (equal to 367.1 million mattresses) yields net benefits of $14.42 to $64.49 per mattress, using a discount rate of 3 percent.

Table 5: Summary of Expected Benefits and Costs of the Draft Proposed Standard, Measured in 2004 $US

	Total Benefits	Costs	Net benefits
PER MATTRESS			
Average Life of 10 Years			
3 percent discount rate	61.66 - 74.25	12.63 - 43.86	17.79 - 61.62
7 percent discount rate	53.22 - 67.80	12.63 - 43.86	9.36 - 50.88
Average Life of 14 Years			
3 percent discount rate	59.88 - 75.71	12.63 - 43.86	16.01 - 63.08
7 percent discount rate	49.01 - 60.89	12.63 - 43.86	5.15 - 48.26
AGGREGATE* (BILLION)			
Average Life of 10 Years			
3 percent discount rate	1.56 - 1.88	0.32 - 1.11	0.45 - 1.56
7 percent discount rate	1.35 - 1.61	0.32 - 1.11	0.24 - 1.29
Average Life of 14 Years			
3 percent discount rate	1.52 - 1.92	0.32 - 1.11	0.41 - 1.60
7 percent discount rate	1.24 - 1.54	0.32 - 1.11	0.13 - 1.22

* Aggregate estimates are based on estimated sales of both conventional and non conventional mattress, estimated to be about 25.3 million in 2004. This reflects the implicit assumption that per mattress costs are equal for conventional and non conventional mattresses.

Net benefits are also positive using discount rates of 3 and 7 percent. Using a 3 percent discount rate, net benefits per mattress equal $17.79 to $61.62 for an average life of 10 years and $16.01 to $63.08 for an average life of 14 years. Using a 7 percent discount rate, net benefits per mattress equal $9.36 to $50.88 for an average life of 10 years and $5.15 to $48.26 for an average life of 14 years. Assuming a larger discount rate reduces net benefits, because future benefits reaped over the life of the mattress contribute less to total benefits.

Net benefits in Table 5 are based on an estimated value of a statistical life equal to $5 million. Changing the estimate used for the value of a statistical life does not have a major impact on the results. For example, if $3 million, the lower bound estimate in Viscusi (1993), is used as an estimate of the value of a statistical life, net benefits become -$2.90 to $36.73

per mattress (using a 3 percent discount rate and an estimated mattress life of 10 years).[33] Alternatively, a $7 million estimate, the higher bound estimate in Viscusi (1993), yields net benefits equal to $38.48 to $86.51 per mattress (using a 3 percent discount rate and an estimated mattress life of 10 years).

Changing the estimate used for the cost of injury will have minimal impact on the results, because the share of benefits from reduced injuries is 16 percent of total benefits. Hence, even if there were no reduction in injuries from the draft proposed standard, the net benefits would be $7.86 to $49.59 per mattress (using a mattress life of 10 years and a 3 percent discount rate).

The analysis assumes that the effectiveness of the draft proposed standard ranges from 80 to 86 percent for deaths and 86 to 92 percent for injuries. The net benefits will remain positive, with a lower effectiveness rate. For example, assuming an effectiveness rate of preventing death of only 55 percent yields net benefits of $1.86 to $39.84 per mattress and aggregate net benefits of 50 million to 1.01 billion dollars from all mattresses produced the first year the draft proposed standard is mandated (using a mattress life of 10 years, a 3 percent discount rate, and the same effectiveness for injuries as used in the baseline analysis). Also, assuming a smaller number of deaths and injuries before the draft proposed standard is mandated (a smaller baseline risk) would still result in positive net benefits. A 25 percent reduction in baseline death and injury risks yields net benefits of $2.38 to $43.06 per mattress and aggregate net benefits of $60 million to $1.09 billion from all mattresses produced the first year the mattress standard is mandated (using a mattress life of 10 years, a 3 percent discount rate, and the estimated effectiveness measures used in the baseline analysis).

Impact on Retail Prices

One of the top four mattress manufacturers in the industry has re-merchandised its product lines to lower the costs of other materials so that total costs (and prices) are the same as they were before the production of mattresses that comply with TB603. Other manufacturers have indicated that they will have to increase their price which, according to some manufacturers and based on reported traditional industry mark-ups, might translate to an increase in the retail price to consumers that could reach approximately four-fold the increase in manufacturer's costs. Hence the average increase in the price at which mattress manufacturers are willing to sell their products (supply price) will be anywhere between the price of a similar mattress without FR material and that price plus four times the increase in the costs of production. Given the presence of at least one company that will not increase the price, it is unlikely that the new average price will be close to the higher end of the range because of competition for market share among manufacturers.

The market (equilibrium) price is determined by the intersection of consumers' willingness to buy and producers' willingness to sell the product at different prices. The value the equilibrium price will take (relative to the price before the introduction of fire resistant mattress/foundation sets) will be affected by the change in the demand and supply

[33] The range for net benefits was derived by subtracting the upper end of the cost range from the lower end of the benefits range to get the lower end of the range for net benefits and subtracting the lower end of the cost range from the higher end of the benefits range to get the higher end of the range for net benefits. Because of this method, both ends of the range for net benefits are a very unlikely occurrence.

curves for fire resistant mattress/foundation sets and their relative elasticities. Assuming that the demand curve is unaffected, the equilibrium price will reflect the price elasticity of demand (i.e. the sensitivity of the change in the quantity demanded to the change in price) as well as the shift in supply. In the short-run, consumers have a relatively elastic demand curve, because they can always postpone the purchase of a durable good, and therefore the increase in the equilibrium price is expected to be much lower than the increase in the supply price (what producers would want to sell the same number of mattress/foundation sets for). Because of the relatively high elasticity of demand, sales are likely to decrease in the short-run. In the long-run, the demand curve is less elastic, and therefore the equilibrium price and quantity (sales) will be higher than the short-run price and quantity.

Given the availability of mattresses whose retail prices will not increase and the competitive nature of the industry, it is possible that, on average, prices will rise by about twice the costs associated with the standard (i.e., retail price mark-up will average about twice the increase in manufacturing costs). Under this assumption, consumers would pay an additional $22.91 ($11.46 * 2) to $79.69 ($39.85 * 2) per mattress/foundation set (compared to the price they would have paid for a current mattress that does not comply with the draft proposed standard.[34] Assuming that the demand curve for mattresses is unaffected by the draft proposed standard, some consumers will choose not to purchase (or at least delay the purchase of) a new mattress/foundation set. These consumers who delay or choose not to purchase a new set will not be getting the value (or benefits) that they would have gained from purchasing a new set. This loss, though difficult to quantify, is sometimes measured as a loss in consumer surplus (McCloskey, 1982).

It is unlikely, however, that the post-standard demand curve for mattresses will be the same as the current demand. Early 2004 market observations indicate consumer and retail enthusiasm about the fire resistant mattresses already available for sale, produced by Serta and Carolina Mattress Guild (*Furniture Today*, April 26th, 2004.) If this enthusiasm generally reflects consumers' preferences, then the demand for mattresses may increase. This would tend to offset any reduction in mattress sales and possible losses in consumer surplus.

Impact on Small Businesses and Other Small Entities

The increase in material and labor costs to meet the draft proposed standard is not likely to be dependent on a firm's size and will therefore not disproportionately affect small businesses.[35] The cost imposed disproportionately (per unit produced) on small businesses will be the cost of testing, information collection and record keeping and quality control/quality assurance programs. While these costs are estimated to be a little over one dollar per mattress per year for average-sized establishments, they could be substantially higher for some small mattress manufacturers. If manufacturers use a qualified prototype to produce mattress/foundation sets for longer than a year or if they use a qualified prototype of the least fire-resistant mattress/foundation construction to represent other mattress/foundation constructions, these costs will be lower. Furthermore, firms with more than one

[34] These cost figures include labor and material costs; testing costs; record-keeping costs; and quality assurance program costs. They do not include the costs to wholesalers, distributors, and retailers or compliance costs because they are not incurred by the manufacturers.

[35] The *Initial Regulatory Flexibility Analysis* (2004) details the expected impact of the draft proposed standard, and other alternatives on small businesses.

establishment, or different firms, may be able to reduce these costs by pooling their testing and quality control programs over all establishments or firms.

Use of prototype pooling across establishments and firms would ameliorate the impact of the draft proposed standard on small businesses. By getting together across different states and regions, small manufacturers who do not share a common market (and therefore do not compete with each other) can resemble a large producer in their testing and quality control/quality assurance efforts and therefore reduce their costs per mattress. It is also expected that some barrier suppliers would be willing to do the testing and quality control/assurance programs for small manufacturers in exchange for a small charge, which will be similar to the average cost per mattress for large businesses, because the volume of output will be large.

Impact on the Environment

The extraction, processing, refinement, and conversion of raw materials to meet the draft proposed standard involve energy consumption, labor, and the use of potentially toxic chemicals. Most manufacturing has some impact on the environment, and manufacturing fire resistant mattresses is no exception. Because the draft proposed standard is a performance standard and does not limit manufacturers' choice of fire resistant inputs to use in the production of mattresses, however, there are several economically viable options to meet the standard that do not impose health risks to consumers or significantly affect the environment.[36] CPSC is currently conducting studies on selected fire resistant materials to assess their potential risk to consumers.[37]

Impact on Children

Deaths and injuries among children constitute a substantial proportion of mattress-related fire losses, and of the potential benefits of the draft proposed standard. Boudreault and Smith (1997) report, based on a field investigation study in 1995 to learn more about cigarette-ignited fires and open-flame fires, that 70 percent of open-flame fires involved child play and that child play was involved in 83 percent of the 150 deaths of children less than five years of age. A National Association of State Fire Marshals 1997 study also indicated that 66 percent of the small open-flame ignitions were reportedly started by children under the age of 15 (21 percent by children under 5).

For virtually all of the fires started by children less than 15 years of age, the ignition was not witnessed by an adult (Boudreault and Smith, 1997). Reducing the likelihood of flashover in the first 30 minutes of the fire may therefore benefit children disproportionately, as it allows enough time for adults to detect the fire and save young children in close proximity to the fire. Also children between 5 and 9 who sometimes do not cooperate with adults and run away from adults to other parts of the occupancy will have enough time to be fetched and rescued by an adult.

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[36] For a detailed analysis of environmental impact of the draft proposed standard, see Franklin (2004).

[37] See Thomas and Brundage (2004) for a qualitative assessment of flame retardant chemicals in mattresses.

Smith and Miller (2004) show that, based on national fire estimates for the years 1995-1999, children younger than 15 accounted for 27 percent of addressable deaths and 23 percent of addressable injuries. They also indicate that the draft proposed standard would reduce deaths and injuries to children ages 5 and younger by 85 to 92 percent and 80 to 87 percent respectively. Deaths and injuries to children ages 5 to 14 were estimated to be reduced by 94 to 97 percent and 88 to 94 percent respectively. This represents a total of 100 to 110 deaths of children less than 15 years of age per year for the 1995-1999 period. It also represents 410 to 440 injuries to children less than 15 years of age for the same period.

9. Alternatives to the Draft Proposed Standard

Alternative Maximum Peak Heat Release Rate (PHRR) and Test Duration

The initial California TB 603 proposal required the duration of the test to last 60 minutes with a maximum PHRR of 150kW. Following industry opposition to this proposal, the California Bureau of Home Furnishings and Thermal Insulation changed the criterion to a maximum of 200 kW PHRR in the first 30 minutes, the requirement for both the federal draft proposed standard and the current TB 603.

Increasing the duration of the test and reducing the PHRR would, according to several input suppliers, increase the resource costs to manufacturers of a queen mattress/foundation set by $15.06 to $50.65 compared to non-complying products (i.e., those not conforming to the draft proposed standard.)[38] Adding the costs to wholesalers, distributors, and retailers, the costs of testing, quality control/assurance programs, record-keeping, and CPSC compliance efforts, yields a total resource cost of the stricter standard (150 kW and 60 minutes) of $16.59 to $55.74 (costs to manufacturers {$15.06 to $50.65} + cost to wholesalers, distributors, and retailers, equal to 10% of costs to manufacturers {$1.51 to $5.06} + 3.2 cents CPSC compliance costs) per mattress. This represents a marginal increase in costs of $3.96 ($16.59 - $12.63) to $11.88 ($55.74 - $43.86) over the costs associated with the draft proposed standard.[39]

Such increase in costs would likely result in consumers facing higher mattress prices. Based on traditional industry mark-ups, the new price may reflect a two- to four-fold increase over the increase in production costs, depending on the relative elasticity of demand and supply for mattresses. This yields a total increase in the average price of a queen mattress/foundation set of $30.11 (2*$15.06) to $202.58 (4*$50.65). Potential benefits of the stricter standard could be higher than the draft proposed standard, but the extent is uncertain.

[38] The lower end of the range is based on barrier price of one supplier, whose capacity is expected to meet 25 to 30 percent of the whole market demand in the short run. The next cheapest alternative costs $24 for the barrier material alone.

[39] These cost estimates (and the resulting marginal increase) should be viewed as approximate since no extensive tests of the barriers have been conducted for 60 minutes, as most manufacturers are focused on meeting the less strict requirements. Input suppliers generally do not assemble and test large numbers of mattresses, and may therefore underestimate reduced labor productivity and/or reduced output per machine (compared to a maximum PHRR of 200 kW for a 30-minute test) due to handling the thicker denser barrier. A number of mattress producers estimate that to meet the stricter standard, manufacturing costs would increase (over those of non-compliant mattresses) by $50 to $70 for a queen-sized set (Furniture/Today, July 21, 2004).

Given an effectiveness rate of greater than 80 percent of the draft proposed standard, the additional benefits of stricter test requirements are limited. Assuming that the stricter standard eliminates 50 percent of the remaining deaths and injuries (i.e., it saves 39 additional lives and prevents 136 additional injuries), then an additional benefit of about $7.66 per mattress is expected. This additional benefit may be lower than the associated costs ($3.96 to $12.63) and thus reduce net benefits. Moreover, a small increase in net benefits may not justify the large increase in retail price that would result from a stricter standard.

A bedding official estimated that such price increases may result in reduction in sales of 25 percent or more (Furniture/Today, July 21, 2004). The larger increase in prices (compared to the less strict test requirements) and the resulting reduction in sales could drive some of the smaller manufacturers out of business. (The stricter standard is more likely to require replacing some existing machines to accommodate the denser barrier material, which would be disproportionately more costly for smaller firms whose machinery is older and less sophisticated.) Since mattresses are durable goods, one would expect a larger drop in sales in the short-run than in the long-run, as consumers choose to keep their old mattresses longer than before. This would make the reduction in sales more pronounced in the short-run, increasing the likelihood that some firms may exit the market. Moreover, if a large number of consumers choose to extend the life of their mattresses for a longer time period, it will take longer to achieve the benefits expected to be associated with the safer mattresses.

Alternative Total Heat Released in the First Part of the Test

TB 603 requires the total heat released during the first 10 minutes of the test to not exceed 25 MJ. The draft proposed standard's stricter criterion (15 MJ in the first 10 minutes) reduces the expected size of the initial fire and hence allows consumers a greater chance to escape the fire and get out of the room, even if the room never reaches flashover. The effectiveness rates presented in the analysis are based on the stricter criterion. Using the TB 603 criterion (25 MJ in the first 10 minutes) would likely reduce estimated benefits (the estimated reductions in deaths and injuries), without having any significant effect on costs. According to several producers, mattresses that use existing barrier technology release total heat that is far below the 25 MJ requirement of TB 603. Therefore, using the TB 603 criterion for the total heat released would not change costs but could potentially reduce the benefits and, hence, the net benefits of the draft proposed standard.

Moreover, because of the small fuel load of ticking materials currently being used, the lower total heat release requirement allows the production of mattress/foundation sets based on a prototype that has not been tested as long as it differs from a qualified prototype only with respect to ticking and the ticking material is not part of the fire resistance solution. Requiring a test for every prototype with a different ticking was rejected by the staff because of the magnitude of the burden it would impose on small producers who do not produce large numbers of any one prototype and who would have been adversely affected by these requirements.

Alternative Testing Requirements

The draft proposed standard requires prototype testing (of three mattress/foundation sets) before a manufacturer starts production of a given mattress design and a confirmatory test of one mattress if more than one establishment or firm are pooling their results. (Manufacturers may sell a mattress/foundation set based on a prototype that has not been

tested if that prototype differs from a qualified prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above.) Though production testing (i.e., random burning of mattress/foundation sets to ensure that all production units meet the standard) is encouraged by the draft proposed standard, as a possible component of the quality assurance program, no specified frequency is set by the draft proposed standard. The individual manufacturer's decision on the frequency of production testing will clearly depend on the efficacy of his/her quality assurance/control efforts.

As an alternative, the proposed Federal standard could, like TB 603, not specify any testing requirements. The absence of testing requirements might, however, reduce manufacturers' incentive to comply. Alternatively, the standard could require production testing with a specified frequency. This specification, however, could result in unnecessary costs if they are not justified given the quality control measures generally undertaken by manufacturers in the absence of the draft proposed standard. Requiring more tests per establishment, prototype, or enterprise will increase the estimated costs per mattress and could reduce net benefits.

Alternative Effective Date

The draft proposed effective date is twelve months from the date of publication of the final rule in the *Federal Register*. Given the length of time needed to ensure the availability of inputs for the production of barrier materials, availability of barriers for mattress producers, and a sufficient volume of inventories at retailers' showrooms, an earlier effective date may result in higher input costs to manufacturers. More importantly, it is expected that smaller manufacturers will be disproportionately affected, as they are more likely to wait to invest in development efforts until the technology is developed by larger firms, or until the draft proposed standard becomes effective. A later effective date (longer than twelve months) could reduce expected net benefits as more fires, deaths, and injuries associated with mattresses would occur between the date of publication in the *Federal Register* and the date the standard becomes effective. The staff is unaware of evidence that small manufacturers would be negatively impacted by a twelve months period relative to a longer period, such as eighteen or twenty-four months. The staff is requesting comments from small businesses on the expected economic impact of the effective date and other requirements of the proposed rule in the regulatory flexibility analysis (Tohamy, 2004).

Taking No Action or Relying on a Voluntary Standard

If the Commission chooses to take no action, the California standard may be enforced and adopted by manufacturers nationwide. It will probably be adopted nationwide by the larger producers to avoid product liability claims associated with a less safe mattress sold in a different area of the country. Three of the largest four producers plan to meet TB 603 nationwide by the end of 2005. Some small California manufacturers may have a smaller incentive to meet TB 603 than a Federal standard. Small manufacturers who do not sell in California may similarly have no incentive to meet TB 603 requirements throughout the country. Hence, expected aggregate net benefits associated with the draft proposed standard are higher than the net benefits that might result under California TB 603.

No effort has been undertaken to develop a voluntary standard. Furthermore, industry representatives support a mandatory standard to level the playing field among domestic producers (large and small) and importers. If a voluntary standard were developed, the economic burden would fall primarily on the larger firms, their market shares could be reduced and benefits to consumers (in terms of reduced deaths and injuries) would likely decline accordingly.

Labeling Requirements

The Commission could require labeling on mattresses to warn consumers in lieu of a standard. Labeling is not considered an effective option for reducing the risk of fires. Since mattress labels are usually covered by bedclothes and may not be seen by the mattress users, labeling mattresses is likely to be ineffective. Moreover, fires started by children who cannot read or do not change the bed sheets will not be reduced by a labeling requirement. Hence, while labeling costs are probably negligible, labels are unlikely to reduce mattress fires.

Labeling of chemically treated components has been suggested as a possible requirement of the draft standard, to inform consumers of the materials used. The costs of such labeling will be negligible, since existing mattresses have labels and producers could probably add a description of the chemical treatment (if any) to the existing label. Labeling of chemically treated components would provide small unquantifiable benefits to consumers as it would allow them to make an informed decision about the mattress/foundation set they choose to buy. Information on the use of chemically treated components may be proprietary and is, therefore, not required on the mattress label by the proposed standard. The draft proposed standard, however, requires this information under its record keeping requirements.

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UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 29, 2004

TO : Margaret Neily, Project Manager for Mattresses

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

FROM : Soumaya M. Tohamy, Ph.D., EC ST

SUBJECT : Initial Regulatory Flexibility Analysis for Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses

Attached is the Initial Regulatory Flexibility Analysis for Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses.

Attachment

Initial Regulatory Flexibility Analysis for Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses*

October 29th, 2004

Soumaya M. Tohamy, Ph.D.
Directorate for Economic Analysis
U.S. Consumer Product Safety Commission

*** 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.**

Table of Contents

Initial Regulatory Flexibility Analysis for Draft Proposed Standard to Address Open-Flame Ignitions of Mattresses

1. Introduction

There were an estimated 18,900 fires where the first item ignited was mattress/bedding in 1998 (the last year for which detailed data comparable to previous years are available). These fires caused an estimated 2,260 civilian injuries, 410 deaths, and $255.4 million in property losses (Smith and Mah, 2002.) The U.S. Consumer Product Safety Commission received in April 2000 a petition for rulemaking to modify the current flammability standard for mattresses to include additional ignition sources. The Commission published an Advance Notice of Proposed Rulemaking (ANPR) in October 2001, initiating a proceeding to develop a mandatory federal standard to address open-flame ignition. As indicated in the preliminary regulatory analysis (Tohamy, 2004), the draft proposed rule addresses open-flame mattress fires that are ignited by a small open flame, smoking materials, or other ignition sources. Some of these ignitions may have started the bedclothes on fire before igniting the mattress. The draft proposed standard would apply to mattress/foundation sets, mattresses sold separately, and futons produced domestically and imported.

The Regulatory Flexibility Act (RFA) requires that rules proposed by the Commission be reviewed for their potential economic impact on small entities, including small businesses. Section 603 of the RFA calls for the Commission to prepare and make available for public comment an initial regulatory flexibility analysis describing the impact of the draft proposed rule on small entities and identifying impact-reducing alternatives. The initial regulatory analysis is required to contain:

a) a description of the reasons why action by the agency is being considered,

b) a succinct statement of the objectives of, and legal basis for, the proposed rule,

c) a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply,

d) a description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities subject to the requirements and the type of professional skills necessary for the preparation of reports or records, and

e) an identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the proposed rule.

Moreover, the initial regulatory flexibility analysis must contain a description of any significant alternatives to the proposed rule that would accomplish the stated objectives of

applicable statues and which minimize any significant economic impact of the proposed rule on small entities. These alternatives may include: (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance and reporting requirements under the rule for such small entities; (3) the use of performance rather than design standards; and (4) an exemption from coverage of the rule, or any part thereof, for such small entities.

The Commission routinely considers potential effects on competition and small businesses as part of the agency's overall evaluation of potential economic effects of rulemaking actions. A summary of these effects is included in the preliminary regulatory analysis (Tohamy, 2004) required for the draft proposed standard under Section 4(i) of the FFA (Flammable Fabrics Act). Since most of the affected firms are considered to be small companies, the Commission is issuing a separate initial regulatory flexibility analysis of the draft proposed standard to analyze the potential economic effects of the draft proposed standard on such firms.

2. Impact on Small Businesses and Other Small Entities

a) Reasons for Agency Action

The draft proposed standard to address open-flame mattress fires addresses the risk of death and injury from mattress residential fires that were started by small open flames, smoking materials, or other ignition sources. As indicated earlier, there were an estimated 18,900 fires where the first item ignited was mattress/bedding in 1998. These fires caused an estimated 2,260 civilian injuries, 410 deaths, and $255.4 million in property losses (Smith and Mah, 2002.) By reducing the likelihood of flashover in the first 30 minutes of the fire, the draft proposed standard will slow the rate of fire spread and thus reduce the risk of injury and death (Smith and Miller, 2004). Because fires will not be eliminated, any reduction in property damage that might result from the proposed rule cannot be quantified.

The Commission is required to consider whether appropriate voluntary standards could adequately address the problem rather than imposing a mandatory rule. No voluntary standard, however, was submitted to the Commission for consideration in response to the ANPR, and the Commission staff is unaware of any voluntary standard that addresses the problem. Deferring to the voluntary standard, therefore, does not represent an alternative to the draft proposed mandatory standard.

b) Objectives of and Legal Basis for the Draft Proposed Standard

The Commission received a petition for rulemaking to modify the current flammability standard for mattresses (codified at 16 CFR Part 1632) in April 2000. The Commission published an Advance Notice of Proposed Rulemaking (ANPR) in October 2001, initiating a proceeding to develop a mandatory federal standard to address open-flame ignition.

The purpose of the draft proposed standard is to reduce the risk of death and injury from mattress fires that are ignited by small open flames, smoking materials, and other ignition sources. It is expected that the draft proposed standard will substantially reduce the

incidence and cost to society of these fires. The standard is being proposed under the authority of the FFA (Flammable Fabrics Act). Section 4(i) of the FFA requires the agency to describe the potential benefits and costs of the draft proposed regulation. The preliminary regulatory analysis (Tohamy, 2004) provides this description.

c) Firms Subject to the Draft Proposed Standard

The draft proposed standard covers producers and importers of mattresses. There were 557 mattress firms and 639 mattress establishments in 2001, according to the Statistics of U.S. Businesses, Census Bureau data.[1] All but the largest twelve firms had less than 500 employees.[2] The U.S. Small Business Administration's Office of Advocacy defines a small business as one that is independently owned and operated and not dominant in its fields. A definition that is used frequently and is less subject to interpretation is a firm with fewer than 500 employees.[3] The latter definition classifies 97.8 percent ((557 - 12) / 557) of all mattress firms as small businesses. Table 1 shows the distribution of mattress firms by enterprise employment size.

Table 1 shows that average employment per firm for the whole industry is 45.8 employees. Average employment for the 1 - 4 employees per enterprise group, which represents 22.98 percent of all firms, is 2.4 employees. Average employment for the less than 20 employees per enterprise group, which represents 61.22 percent of all firms, is 6.2 employees. Hence more than half of mattress firms have less than 20 employees.

In addition to domestic producers, importers will be affected by the draft proposed standard. Imported mattresses represent less than two percent of total U.S. shipments.

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[1] 2002 Economic Census data, which divide establishments by employment size of the establishment and not the firm or enterprise, show that all mattress establishments had less than 500 employees in 2002.

[2] The Census uses North American Industry Classification Code (NAICS) 33791 for this measure. The firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and establishment are the same for single-establishment firms. For each multi-establishment firm, establishments in the same industry within a state are counted as one firm. The firm and enterprise are the same for national data collection purposes. The firm employment and annual payroll are summed from the associated establishments.

[3] Appendix B: Small Business by Numbers, *The Regulatory Flexibility Act*, p. 90.

Table 1: Number of U.S. Mattress Establishments by Enterprise Employment Size, 2001*

	Total	Employment Size of the Enterprise^								
		0**	1-4	5-9	10-19	<20	20-99	100-499	<500	500+
Firms^^	557	27	128	97	89	341	168	36	545	12
Percent of total	100%	4.85%	22.98%	17.41%	15.98%	61.22%	30.16%	6.46%	97.85%	2.15%
Employment	25,500	0	308	645	1,173	2,126	7,684	5,467	15,277	10,223
Annual Payroll ($1000)	770,601	987	6,817	12,489	26,183	46,476	208,787	166,731	421,994	248,607
Average Employment per Firm	45.8		2.4	6.6	13.2	6.2	45.7	151.9	28.0	851.9
Average Annual Wage	30,220		22,133	19,363	22,321	21,861	27,172	30,498	27,623	34,100

Source: U.S. Census Bureau (http://www.census.gov/csd/susb/susb01.htm)

* North American Industry Classification System (NAICS) Code 33791 is used for the definition of the mattress industry.

^ An enterprise is a business organization consisting of one or more domestic establishments under common ownership or control. Employment size is determined only for the entire enterprise.

** This group includes firms for which no associated establishment reported paid employees in the mid-March pay period but paid employees at some time during the year.

^^ A firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. A firm is the same as an enterprise in this table because it represents only national data.

d) Requirements of the Draft Proposed Standard and Possible Impacts on Small Businesses

The draft proposed standard will apply to all mattresses, where mattresses include a ticking (i.e., an outer layer of fabric) filled with a resilient material used alone or in combination with other products intended or promoted for sleeping upon. This definition includes adult mattresses (and accompanying foundations, treated jointly as a set); youth mattresses; crib mattresses, including portable crib mattresses; bunk bed mattresses; futons; flip chairs; water beds and air mattresses which contain upholstery material between the ticking and the mattress core; and any mattresses used in items of upholstered furniture such as convertible sofa bed mattresses. It does not include sleeping bags, mattress pads, or any top of the bed articles. Options for meeting the standard include one or a combination of fire resistant ticking, chemically treated or otherwise fire resistant filling products, or a fire blocking barrier (either a sheet style barrier or a high-loft barrier, sometimes called a fiber barrier).

The draft proposed standard is a performance standard, not a design standard, and hence allows producers to choose their own technology to meet the mattress/foundation set test requirements. All mattress/foundation sets subject to the draft proposed standard must be tested in prototype and meet the specified performance requirements before production.[4] For each prototype, three mattress/foundation sets must be tested.[5] A qualified prototype is one that has been tested in triplicate and meets the performance requirements for all three mattress/foundation sets. A failure of any of the sets would require that a modified prototype be tested and pass the test (in triplicate). Each mattress/foundation set must pass a burn test where the peak heat release rate (PHRR) does not exceed 200 kilowatt (kW) for the full 30 minutes and the total heat release does not exceed 15 megajoules (MJ) in the first 10 minutes of the test. A manufacturer may sell mattress/foundation sets produced according to a prototype that has not been tested if that prototype differs from a qualified prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above.

Manufacturers are required to keep records of all tests performed and their results including video or pictures; prototype or production identification number; date and time of test; and name and location of testing facility; test room conditions; and test data for as long as the prototype is in production and for three years after its production ceases. They are also required to keep records of a unique identification number for the qualified prototype and a list of the unique identification numbers of each prototype based on the qualified prototype and a description of the materials substituted and/or the size change. Moreover, they are required to document the name and supplier of each material used in construction of a

[4] The rationale for the draft proposed standard, its testing requirements, and a description of set-up and heat contribution of test burners are described in detail in Tenney (2004).

[5] A prototype is defined as a specific design of mattress and corresponding foundation, if any, which serves as a model for production units intended to be introduced into commerce (Section 1633.2 (j) of the draft proposed standard). This definition implies that any change to the size, ticking, and/or any other component of the mattress/foundation set assembly results in a different prototype.

prototype and keep physical samples of the material. Additionally, they are required to identify the details of the application of any fire retardant treatments and/or inherently fire resistant fibers employed relative to mattress components. Finally, they are required to have an adequate quality assurance program in place.

The increase in material and labor costs of the draft proposed standard (estimated in the regulatory analysis (Tohamy, 2004) to be $10.41 to $38.80 per mattress) is not likely to be dependent on a firm's size and will therefore not disproportionately affect small businesses. Larger firms are bearing all the capital investment costs of research and development, sharing some of these costs with input suppliers. Most smaller firms will simply buy from the suppliers a barrier solution, which has been tested extensively and is known to meet the standard. The price these smaller firms pay to cover the developments and testing costs borne by the supplier but will not have a disproportionate adverse impact on them, because the price is not measured relative to their small output, but relative to the supplier's output. Other smaller firms may combine their development efforts to be able to benefit from dividing the costs over a larger number of firms. Finally, small mattress producers that do not assemble the mattress panels (the quilted assembly, including ticking, batting material, and barrier, used to cover the contents of the mattress construction), but buy them from a panel supplier are effectively combining all their output in a "pooling" arrangement. This is because the panel supplier will be responsible for including a barrier in the panel assembly and will pass that cost on to the mattress producers, again not disproportionately impacting the small producers who buy the already assembled panels.

The costs more likely to be imposed disproportionately (per unit produced) on small businesses will be the costs of testing, information collection and record keeping, and quality control/quality assurance programs. While the regulatory analysis estimates these costs (including the cost of compensating clerical staff for record-keeping and quality control/quality assurance requirements) to be a little over one dollar per mattress per year for average-sized establishments, they could be substantially higher for some small mattress producers (Tohamy, 2004). If manufacturers use a qualified prototype to produce mattress/foundation constructions for longer than a year, or if they use a qualified prototype of the least fire-resistant mattress/foundation construction to represent other mattress/foundation constructions, these costs will be lower. Furthermore, firms with more than one establishment may be able to reduce these costs by pooling their prototypes and quality control programs over all establishments. Small independent firms could also use prototype pooling to reduce their costs per mattress/foundation set.

Use of prototype pooling across establishments and firms would ameliorate the impact of the draft proposed standard on small businesses. By getting together across different states and regions, small manufacturers who do not share a common market (and therefore do not compete with each other) can resemble a large manufacturer in their testing and quality control/quality assurance efforts and therefore reduce their costs per mattress. It is also expected that some barrier suppliers would be willing to do the testing and quality control/assurance programs for small manufacturers in exchange for a small charge, which will be similar to the average cost per mattress/foundation set for large businesses, because the volume of output will be large.

e) Other Federal Rules

The staff is not aware of any Federal rules that may duplicate, overlap, or conflict with the draft proposed rule. The existing mattress flammability standard (codified at 16 CFR Part 1632) requires mattresses to resist ignition from cigarettes and uses lighted cigarettes for the test. The scope of the draft proposed standard differs from that of the existing standard and hence complements it.

3. Alternatives to the Draft Proposed Standard

a) Alternative Maximum Peak Heat Release Rate (PHRR) and Test Duration

The initial California TB 603 proposal required the duration of the test to last 60 minutes and a maximum PHRR of 150 kW. Following industry opposition to this proposal, the California Bureau of Home Furnishings and Thermal Insulation changed the criterion to a maximum of 200 kW PHRR in the first 30 minutes, the requirement for both the federal draft proposed standard and the current TB 603.

As described in the regulatory analysis (Tohamy, 2004), increasing the duration of the test and reducing the PHRR would, according to several input suppliers, increase the resource costs to manufacturers of a queen mattress/foundation set by $15.06 to $50.65 compared to non-complying products (i.e., those not conforming to the draft proposed standard.)[6] Adding the costs to wholesalers, distributors, and retailers, the costs of testing, quality control/assurance programs, record-keeping, and CPSC compliance efforts, yields a total resource cost of the stricter standard (150 kW and 60 minutes) of $16.59 to $55.74 (costs to manufacturers {$15.06 to $50.65} + cost to wholesalers, distributors, and retailers, equal to 10% of costs to manufacturers {$1.51 to $5.06} + 3.2 cents CPSC compliance costs) per mattress. This represents a marginal increase in costs of $3.96 ($16.59 – $12.63) to $11.88 ($55.74 - $43.86) over the costs associated with the draft proposed standard.[7]

Such increase in costs would likely result in consumers facing higher mattress prices. Based on traditional industry mark-ups, the new price may reflect a two- to four-fold increase over the increase in production costs, depending on the relative elasticity of demand and supply for mattresses. This yields a total increase in the average price of a queen mattress/foundation set of $30.11 (2*$15.06) to $202.58 (4*$50.65). This might make the cost to consumers of the stricter standard (150 kW and 60 minutes), measured in terms of higher prices, greater than the benefit they would receive, measured in terms of reduced deaths and injuries. Potential benefits of the stricter standard could be higher than the draft

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[6] The lower end of the range is based on barrier price of one supplier, whose capacity is expected to meet 25 to 30 percent of the whole market demand in the short run. The next cheapest alternative costs $24 for the barrier material alone.

[7] These cost estimates (and the resulting marginal increase) should be viewed as approximate since no extensive tests of the barriers have been conducted for 60 minutes, as most manufacturers are focused on meeting the less strict requirements. Input suppliers generally do not assemble and test large numbers of mattresses, and may therefore underestimate reduced labor productivity and/or reduced output per machine (compared to a maximum PHRR of 200kW for a 30-minute test) due to handling the thicker denser barrier. A number of mattress producers estimate that to meet the stricter standard, manufacturing costs would increase $50 to $70 for a queen-sized set (Furniture/Today, July 21, 2004).

proposed standard, but the extent is uncertain. Given an effectiveness rate of greater than eighty percent of the draft proposed standard, the additional benefits of stricter test requirements are limited. Assuming that the stricter standard eliminates fifty percent of the remaining deaths and injuries (i.e., it saves 39 additional lives and prevents 136 additional injuries), then an additional benefit of about $7.66 per mattress is expected. This additional benefit may be lower than the associated costs ($3.96 to $12.63) and thus reduce net benefits. Moreover, a small increase in net benefits may not justify the large increase in retail price that would result from a stricter standard.

A bedding official estimated that such price increases may result in reduction in sales of 25 percent or more (Furniture/Today, July 21, 2004). The larger increase in prices (compared to the less strict test) and the resulting reduction in sales could drive some of the smaller producers out of business. (The stricter standard is more likely to require replacing some existing machines to accommodate the denser barrier material, which would be disproportionately more costly for smaller firms whose machinery is older and less sophisticated.) Since mattresses are durable goods, one would expect a larger drop in sales in the short-run than in the long-run, as consumers choose to keep their old mattresses longer than before. This would make the reduction in sales more pronounced in the short-run, increasing the likelihood that some firms may exit the market. Moreover, if a large number of consumers choose to extend the life of their mattresses for a longer time period, it will take longer to achieve the benefits expected to be associated with the safer mattresses.

b) Alternative Total Heat Released in the First Part of the Test

TB 603 requires the total heat released during the first 10 minutes of the test to not exceed 25 MJ. The draft proposed standard's stricter criterion (15 MJ in the first 10 minutes) reduces the expected size of the initial fire and hence allows consumers a greater chance to escape the fire and get out of the room, even if the room never reaches flashover. The effectiveness rates presented in the analysis are based on the stricter criterion. Using the TB 603 criterion (25 MJ in the first 10 minutes) would likely reduce estimated benefits (the estimated reductions in deaths and injuries), without having any significant effect on costs. According to several producers, mattresses that use existing barrier technology release total heat that is far below the 25 MJ requirement of TB 603. Therefore, using the TB 603 criterion for the total heat released would not change costs but could potentially reduce the benefits and, hence, the net benefits of the draft proposed standard.

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test of one mattress if more than one establishment or firm are pooling their results. (Manufacturers may sell a mattress/foundation set based on a prototype that has not been tested if that prototype differs from a qualified prototype only with respect to (1) mattress/foundation size; (2) ticking, unless the ticking of the qualified prototype has characteristics designed to improve performance on the burn test; and/or (3) the manufacturer can demonstrate, based 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 above.) Though production testing (i.e., burning mattress/foundation sets to ensure that all production units meet the standard) is encouraged by the draft proposed standard, as a possible component of the quality assurance program, no specified frequency is set by the draft proposed standard. The individual manufacturer's decision on the frequency of production testing will clearly depend on the efficacy of his/her quality assurance/control efforts.

As an alternative, the Federal standard could, like TB 603, not specify any testing requirements. The absence of testing requirements might, however, reduce manufacturers' incentive to comply. Alternatively, the standard could require production testing with a specified frequency. This specification, however, could result in unnecessary costs if they are not justified given the quality control measures generally undertaken by producers in the absence of the draft proposed standard. Requiring more tests per establishment, prototype, or enterprise will increase the estimated costs per mattress and could reduce net benefits.

d) Alternative Effective Date

The draft proposed effective date is twelve months from the date of publication of a final rule in the *Federal Register*. Given the length of time needed to ensure the availability of inputs for the production of barrier materials, availability of barriers for mattress producers, and a sufficient volume of inventories at retailers' showrooms, an earlier effective date may result in higher input costs to producers. More importantly, it is expected that smaller producers will be disproportionately affected, as they are more likely to wait to invest in development efforts until the technology is developed by larger firms, or until the standard becomes effective. A later effective date (longer than twelve months) could reduce expected net benefits as more fires, deaths, and injuries associated with mattresses would occur between the date of publication of a final rule in the *Federal Register* and the date the standard becomes effective. The staff is unaware of evidence that small producers would be negatively impacted by a twelve months period relative to a longer period, such as eighteen or twenty-four months. The staff is requesting comments (in Section 4) from small businesses on the expected economic impact of the effective date and other requirements of the proposed rule.

e) Taking No Action or Relying on a Voluntary Standard

If the Commission chooses to take no action, the California standard may be adopted by manufacturers nationwide. It will probably be adopted nationwide by the larger producers to avoid product liability claims associated with a less safe mattress sold in a different area of the country. Three of the largest four producers plan to meet TB 603 nationwide by the end of 2005. Some small California manufacturers may have a smaller incentive to meet TB 603 than a Federal standard. Small manufacturers who do not sell in California may similarly have no incentive to meet TB 603 requirements throughout the country. Hence, expected

aggregate net benefits associated with the draft proposed standard are higher than the net benefits that might result under California TB 603.

No effort has been undertaken to develop a voluntary standard. Furthermore, industry representatives support a mandatory standard to level the playing field among domestic producers (large and small) and importers. If a voluntary standard were developed, the economic burden would fall primarily on the larger companies, their market shares could be reduced significantly and benefits to consumers (in terms of reduced deaths and injuries) would likely decline accordingly.

f) Labeling Requirements

The Commission could require labeling on mattresses to warn consumers in lieu of a standard. Labeling is not considered an effective option for reducing the risk of fires. Since mattress labels are usually covered by bedclothes and may not be seen by the mattress users, labeling mattresses is likely to be ineffective. Moreover, fires started by children who cannot read or do not change the bed sheets will not be reduced by a labeling requirement. Hence, while labeling costs are probably negligible, labels are unlikely to reduce mattress fires.

Labeling of chemically treated components has been suggested as a possible requirement, to inform consumers of the materials used. The costs of such labeling would be negligible, since existing mattresses have labels and producers could probably add a description of the chemical treatment (if any) to the existing label. Labeling of chemically treated components would provide small unquantifiable benefits to consumers as it would allow them to make an informed decision about the mattress/foundation set they choose to buy. Information on the use of chemically treated components may be proprietary and is, therefore, not required on the mattress label by the proposed standard. The draft proposed standard, however, requires this information under its record keeping requirements.

4. Questions for Comment to Assist Regulatory Flexibility Analysis

The CPSC staff requests comments on any or all of the provisions in the draft proposed rule with regard to (1) the impact of the provisions (including any benefits and costs), if any, on small entities and (2) what alternatives, if any, the Commission should consider, as well as the costs and benefits of those alternatives to small entities in light of the above analysis. In particular, please provide the above information with regard to the following:

- prototype and confirmation testing requirements of the draft proposed rule,

- quality control/quality assurance program requirements of the draft proposed rule,

- record keeping requirements of the draft proposed rule, and

- an effective date of twelve months from the date of publication of a final rule in the *Federal Register.*

Moreover, it would be useful to receive comments on ways in which the rule could be modified to reduce any costs or burdens for small entities, and describe whether and how

technological developments could reduce the costs of implementing and complying with the rule for small entities.

5. Summary and Conclusions

The draft proposed standard to address open-flame ignition of mattresses will affect all mattress manufacturers. Almost all of these firms would be considered small businesses, using the Small Business Administration definition. Material and labor costs for all firms are expected to initially increase on average by $10 to $39 per mattress set produced (Tohamy, 2004). These cost increases are expected to be borne equally by all firms and hence do not have a disproportionate adverse impact on the smaller mattress producers. These costs are expected to decline in the future due to improved technology of producing fire resistant materials and increased competition among suppliers of inputs used by the mattress industry.

Testing, record keeping, and quality control/quality assurance requirements may have a disproportionate impact on small manufacturers because they are generally required per firm or per prototype and therefore would constitute a larger percent of total revenues, sales, and value added for the smaller firms. To minimize the adverse impact on small manufacturers, the draft proposed standard provides for prototype pooling among different establishments within the same firm and among different firms. The draft proposed standard would also allow selling mattress/foundation sets whose prototypes differ from a qualified prototype only with respect to size, and/or ticking material or other components that do not impact the fire performance of the prototype without testing the prototypes, to minimize testing costs to all manufacturers, especially those whose volume of output is small.

Compared to other effective alternatives considered, the draft proposed standard minimizes the impact on small businesses. The only alternatives that might have a lower adverse impact on small business are labeling or doing nothing. Either alternative is ineffective in reducing the fires, deaths, and injuries associated with mattresses and, therefore, not recommended.

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