

BY VINCENT DIAZ

The hectic pace of today's lifestyle means that by the end of the day, most of us are ready to lay our heads down for a safe and peaceful night's sleep.

Unfortunately, thousands of people each year are suddenly awakened during the night by the terror of a bedroom fire. In seconds, their thoughts immediately race to the safety and whereabouts of spouses, children, parents, and anyone else who might be at home.

After a quick tally of people, other questions come to mind: "What's happening?" "How can I escape?" In a few moments they also start wondering about the most frightening question, "How much time do I have to get out?"

The answers to these questions are being addressed by a series of regulations that were initiated after the California State Assembly passed Assembly Bill 603 in August 2001.¹ This bill amended the California Home Furnishings and Thermal Insulation Act by mandating an open flame standard for mattress sets and futons sold in California.

Subsequent to the promulgation of this law and, especially after the advanced notice of proposed rule-making issued by the U.S. Consumer Product Safety Commission in October 2001, the textile supply chain went into action to make sure that mattress manufacturers could meet the original effective date of this law, January 1, 2004.

WHY A STATE REGULATION?

The mattresses in our homes are made of a variety of extremely flammable materials. As noted by one official, "a mattress is made of soft gasoline." A mattress fire can become catastrophic in a few minutes.

Firefighters who answer the alarm for a house fire are very much

aware of a critical phenomenon that can dramatically increase the potential for danger to anyone inside a structure as well as to the structure itself. The phenomenon is called flashover. Essentially, a flashover occurs when the heat energy in a room reaches 1,000 kW. When this situation occurs, virtually everything in the room immediately becomes combustible — a room of flames.

In about three minutes a burning mattress becomes a fireball that can reach a level of heat energy in excess of 800 kW. When this load of heat energy is combined with other flammable textile products such as curtains or drapes, carpeting, comforters, even dirty clothes, a dangerous heat level is quickly reached. All of this can reduce the time for escape to just a few minutes.

Each year, mattress fires cause

more than 500 deaths, thousands of injuries and more than a quarter billion dollars in property damage.

The passage of Assembly Bill 603 meant that the textile supply chain had to focus on meeting a rigid set of open-flame performance requirements for mattresses. At the same time, they had to help their customers differentiate between testing a mattress to the existing cigarette burn test and the much more rigorous AB603 open flame test. The suppliers faced two hurdles: (1) How to help their mattress manufacturing customers understand that a single failure that results in either injury or death will put their company's future in jeopardy and (2) How to help them explain to their retail customers why the extra cost for this safety feature is valuable and beneficial.



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SLEEP

trolled while generating less than 200 kW of heat energy (20 percent of flashover threshold).

SUPPLIER QUALITY STRATEGY

TB603 is a composite test. This means that the open-flame test is used to show how any manufactured mattress, that would be purchased by a consumer, will behave. Because the regulation implies that every assembled mattress will pass this test, component suppliers are cognizant that they will be named in any litigation where injury or death has occurred.

The assembly of a mattress is similar to other multicomponent products, such as automobiles, refrigerators, computers, etc. Component suppliers in these other industries are usually obligated to demonstrate continuous improvement by being certified to recognized QA programs such as ISO 9000, QS14000, Six Sigma, etc.

For example, automobile manufacturers limit the purchase of critical safety components such as airbags and seat belts to outside vendors that can provide quality assurance data for every production lot. Likewise, mattress manufacturers also need to be able to purchase critical safety components, such as thermal barrier fabric, flame resistant edge binding tapes, and inherently flame

PERFORMANCE REQUIREMENTS

The original performance requirements established in AB603 were modified following several studies conducted by the National Institute of Standards and Technology.^{2,3,4} These projects, sponsored by the International Sleep Products Association, determined that there was a correlation between the ignitability of bedclothes — sheets, comforters, blankets, etc. — and a mattress' combustibility.

Data from this study were included in the development of the technical standard used by the California Department of Consumer Affairs' Bureau of Home Furnishings and Thermal Insulation, the state agency responsible for verifying compliance and enforcement of the law.

The testing protocol, Technical Bulletin 603,⁵ incorporated the procedures and test apparatus used in the National Institute of Standards and Technology's study.⁶

Technical Bulletin 603 evaluates a complete mattress set by simultaneously impinging one open flame vertically along the side of a mattress at the mattress/boxspring interface for 50 seconds and a second open flame horizontally along the top sleep surface of the mattress for 70 seconds. For 30 minutes, subsequent to the open flame exposure, a mattress must demonstrate one of two performance behaviors in order to pass the test:

1. It will self-extinguish in less than 30 minutes. With this result, there is no chance of failing TB603.
2. If it burns for the 30-minute test duration, the fire must be con-



resistant thread from outside vendors that can provide these types of data.

Knowing that the performance of each individual component can contribute to the success of the composite test, component manufacturers determined that ongoing evaluation of critical components would need to be done to achieve two objectives:

- Mitigate the chance of using any component that could contribute to a failure by maintaining a quality assurance program.
- Assist the manufacturer by supplying product certification that can be used as part of its record-keeping system. This information also provides verification for enforcement or inspection agencies that the critical components currently being purchased and used in manufacturing are the same components that were used for the initial composite testing that was performed to determine compliance to TB603. Product certification also confirms that these same components are regularly evaluated for consistency of performance.

Members of the textile supply chain approached ASTM Committee D13 on Textiles, specifically Subcommittee D13.52 on Flammability of Textiles, to help develop test methods that could be used to evaluate critical textile components that would be used in mattress manufacturing.

A SYSTEM OF COMPONENTS

Between the enactment of AB603 in August 2001 and its delayed effective date of implementation in January 2005, the Bureau of Home Furnishings and Thermal Insulation sponsored a number of workshops during which they discussed a series of compliance strategies. These strategies outlined a system of flame resistant critical components. Using a system of critical components creates a closure that acts as a heat shield for the encapsulated polyurethane foam and other combustible components used in the mattress interior. The system includes the use of thermal barrier fabrics, flame-resistant edge

binding tape, and inherently flame-resistant sewing thread. It was noted by BHFTI that using flame-resistant edge tape and sewing thread to secure and close the exterior perimeter of the thermal barrier fabric would enhance the flame resistance of the mattress.

While using an interdependent system of components is important, the workshop speakers also mentioned the value of regular and ongoing testing of mattress units to confirm compliance to TB603.

QUALITY ASSURANCE

Since 2001, the following relevant consensus standards have been developed in ASTM Committee D13. These test methods are intended to measure the critical failure modes of the components that could cause the composite mattress structure to fail.

ASTM D 7016, Standard Test Method to Evaluate Edge Binding Components Used in a Mattress After Exposure to an Open Flame — This standard is a small-scale test that evaluates the critical components used in mattresses: sewing thread, tape edge binding, and the subassembly created when the tape edge and sewing thread encapsulate the fire barrier.

The test method evaluates:

1. Thread
 - a. Measures if thread melts at an elevated temperature.
 - b. Measures break strength of sewing thread before and after exposure to high heat for 30 minutes.
 - c. Confirms that after the high heat exposure, sewing thread retains minimum break strength equal to 65 percent of the original break strength.
2. Edge Binding Tape
 - a. Tape must extinguish in less than 5 seconds after exposure to vertical flame.
 - b. Tape is subjected to five wash cycles that represent a mattress being exposed to water, coffee, beer, urine, or other body fluids. After these washes, tape is exposed to vertical flame; it must again

extinguish in less than 5 seconds.

3. Subassembly
 - a. Tape, thread, and fire barrier are sewn as a combination and exposed to an open flame for 60 seconds.
 - b. The subassembly must self-extinguish in less than 10 minutes.
 - c. Sewn seam integrity must remain intact.

ASTM D 7140, Standard Test Method to Measure Heat Transfer Through Materials Used as Thermal Barriers — This standard is a small-scale test that can be used as part of a quality assurance program to measure heat transfer across the full width of any thermal barrier fabric.

Using the same heat flux as required in the TB603 test, the method can distinguish between those barrier fabrics that change configuration, burn away or ablate when exposed to heat, as well as those that change configuration by shrinking and becoming more dense.

Conformance Reports

By using these ASTM standards, critical component suppliers that establish quality assurance programs would be able to supply mattress manufacturers with certificates of conformance for each lot of components.

Third party auditors, such as SGS/US Testing have initiated verification programs for critical component suppliers using these ASTM test methods.

While large mattress manufacturers might choose to perform additional incoming raw material testing, small manufacturers, with fewer personnel, could opt to use these certificates of conformance to verify product quality.

QUALITY CONTROL

Component suppliers have strongly encouraged manufacturers to incorporate quality control systems in their manufacturing processes.

Several suppliers whose individual components demonstrated consistent levels of performance using

the ASTM test methods became concerned about the statistically high rate of composite mattress failures. After analyzing the relevant data, these suppliers determined that the primary cause of failure was the assembly process.

They concluded that a quality control program that identifies potential problems and their solutions can reduce the chance for failure and minimize product liability litigation.

Supplier Quality Control Program

Several suppliers offer systems so that mattress manufacturers can have a greater probability of passing TB603. Mattresses made using these systems have demonstrated exceptional results. Data have shown that a statistically high percentage of mattresses that are manufactured using these systems, and then tested using TB603, will self-extinguish in less than 20 minutes.

NATIONAL STANDARD

In January 2005, the CPSC published its Notice of Proposed Rulemaking for Flame Resistant Mattresses.⁷ Although at press time the final details of the national standard for mattress flammability are not yet published, the performance requirements are likely to be no less stringent than those of TB603.

CONCLUSION

Since January 2004, the textile supply chain has been ready to meet the demands of every mattress manufacturer for the critical components needed to build mattresses that meet the open flame performance requirements of TB603.

When fire barrier fabric, edge binding tape, and flame resistant sewing thread are evaluated using the test methods developed by ASTM Committee D13, the mattress manufacturer can have confidence in these critical components. Using a system that combines these components with assembly processes that are focused on consistent quality control can result in passing TB603 with a high success rate. //



Burner positioning for TB603 test.



TB603 test begins.

References

- 1 Assembly Bill 603, Chapter 199, Amendment to Sections 19089.5, 19161, and 19170 of the Business and Professions Code, relating to home furnishings, approved August 2001
- 2 NIST IR 6497, Flammability Assessment Methodology for Mattresses, June 2000
- 3 NIST TN 1446, Estimating Reduced Fire Risk Resulting from an Improved Mattress Flammability Standard, August 2002
- 4 NIST TN 1449, Effect of Bed Clothes Modifications on Performance of Bed Assemblies, February 2003.
- 5 Technical Bulletin 603, Requirements and Test Procedures for Resistance of a Mattress/Boxspring Set to a Large Open Flame, January 2004
- 6 NIST IR 7006, Flammability Tests of Full Scale Mattresses: Gas Burners versus Burning Bedclothes, July 2003.
- 7 16 CFR Parts 1633 and 1634, Standard for the Flammability (Open Flame) of Mattresses and Mattress Foundation Sets; Standard to Address Open Flame Ignition of Bedclothes; Proposed Rules, January 2005



VINCENT DIAZ is an officer of Committee D13 on Textiles. While serving as vice chairman for special assignments, he was asked to assist D13.52 in addressing technical challenges related to flammability of textile components and structures used in mattresses. His 25 years of experience with fire-resistant textiles and protective clothing contributed to the development of test methods D 7016 and D 7140.