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Book of Abstracts
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Kellie Ann Beall, Editor

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Gaithersburg, Maryland 20899

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ESTABLISHMENT OF CONE CALORIMETER ACCEPTANCE CRITERIA FOR EVALUATION OF FIRE RESTRICTING MATERIALS FOR HIGH SPEED CRAFT

Marc Janssens, Southwest Research Institute
Andrew Grenier, U.S. Coast Guard
Louis Nash, U.S. Coast Guard

Introduction

On 1 January 1996, the High Speed Craft Code (HSC) entered into force as part of the Safety of Life at Sea (SOLAS) convention. This code deals with all aspects of the construction and operation of high speed craft. The most common type of ships that are regulated by the code are passenger and vehicle ferries that operate within 4 hours from the shore. The code permits that a high speed craft be constructed of combustible materials, provided certain fire performance criteria are met. Materials that meet these criteria are referred to as "fire restricting materials." The determination of fire restricting materials is based primarily on one of two tests. Bulkhead lining, and ceiling materials are tested using the ISO 9705 room corner test. Acceptance criteria for ISO 9705 are published in IMO resolution MSC.40(64) (MSC 64/22/Add.1, Annex 4). Furniture components (other than fabrics, upholstery, or bedding) and other components are tested using the ISO 5660 Cone calorimeter. No acceptance criteria are published for ISO 5660.

Research Program at Southwest Research Institute (SwRI)

This paper summarizes a research program that was conducted at SwRI between August 1997 and July 1998. The program was funded by the U.S. Coast Guard (USCG). The primary objectives of the program were to establish acceptance criteria to qualify materials as fire restricting based on performance in the Cone calorimeter test, and to determine whether the general IMO surface flammability and smoke and toxicity requirements for finish materials are consistent with and perhaps redundant to the requirements for fire restricting materials. Eight composite materials and one textile wallcovering were tested in full-scale in the ISO 9705 room. The same materials were also evaluated in small-scale according to the test procedures of the Cone calorimeter, the IMO surface flammability test (Part 5 of the IMO Fire Test Procedures or FTP Code), and the IMO smoke and toxicity test (Part 2 of the FTP Code). Some of the composite materials were used as framing materials for mock-up chairs and luggage racks. The upholstery of the chairs consisted of a foam/fabric combination that meets the requirements of IMO Resolution A.652(16), "Recommendation on Fire Test Procedures for Upholstered Furniture." Room tests were conducted on these items. The primary objective of the additional full-scale tests was to determine whether the Cone calorimeter acceptance criteria for linings developed in this study, are suitable pass/fail limits for fire restricting materials used as components of contents.

Additional ignition, flame spread, and release rate measurements were made to obtain material properties for modeling. The results of this part of the study are not reported in this paper.

Summary of Standard Test Results

The results of the standard tests are summarized in Table 1. Materials #1 and #6 slightly exceeded the smoke production limits in the ISO 9705 room test. Material #6 is identical to material #5, painted with an intumescent coating. Material #7 did not exceed the ISO 9705 criteria for heat release and smoke production, but failed due to the fact that flaming debris fell to the floor during the test. However, flaming persisted for only a few seconds. Furthermore, this phenomenon occurred only once during the test.

Table 1. Summary of standard test results

Material	#	ISO 9705	FTP Code Part 2	FTP Code Part 5
FR phenolic	1	Fail (no flashover)	Pass	Pass
Fire restricting material	2	Pass	Fail	Pass
FR polyester	3	Fail (flashover @ 6.2 min)	Fail	Fail
FR vinylester	4	Fail (flashover @ 5.3 min)	Fail	Fail
FR epoxy	5	Fail (flashover @ 16.5 min)	Fail	Pass
Coated FR epoxy	6	Fail (no flashover)	Pass	Pass
Textile wallcovering	7	Fail (no flashover)	Fail	Pass
Polyester	8	Fail (flashover @ 1.8 min)	Fail	Fail
FR modified acrylic	9	Fail (flashover @ 11.1 min)	Fail	Fail

Main Conclusions

The proposed Cone calorimeter acceptance criteria for fire restricting materials that resulted from this work are as follows: 1. time to ignition (t_{ig}) greater than 20 sec; 2.maximum 60 sec sliding average heat release rate ($HRR_{60,max}$) less than 60 kW/m^2; 3. total heat release (THR) less than 12 MJ/m^2; 4. maximum 60 sec smoke production rate ($SPR_{60,max}$) less than 0.01 m^2/s; and 5. average smoke production rate (SPR_{avg}) below 0.005 m^2/s. These values are averages from three tests at a heat flux level of 50 kW/m^2, in the horizontal orientation, with the retainer frame. The criteria are similar to those proposed to IMO by Finland in 1996, based on an analysis of data from the EUREFIC program.

There is an inconsistency between the IMO smoke and toxicity test requirements, and the ISO 9705 room test criteria for fire restricting materials. For example, material # 2 performed very well in the room (minimal heat and smoke production), but failed the IMO smoke and toxicity test requirements due to excessive CO generation under non-flaming conditions at a heat flux level of 50 kW/m^2.

The IMO surface flammability test criteria for finish materials appear to be slightly less stringent than the heat release rate criteria for fire restricting lining materials. Only material # 5 met the IMO surface flammabilty criteria, but failed in the room/corner test due to excessive heat release. However, the time to flashover was the longest for this material, so there seems to be some consistency between the two tests.

The room tests on contents confirmed that materials which meet the requirements for fire restricting linings can safely be used as framing materials and components of furniture and contents. The requirements could perhaps be relaxed, but a hazard or risk assessment is needed to develop revised acceptance criteria that do not compromise safety.