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Hughes Associates, Inc. 3610 Commerce Drive, Suite 817 Baltimore, MD 21227-1652	U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340-6096	11. Contract or Grant No.: DTCG39-99-F-E00159

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15. Supplementary Notes

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16. Abstract

The full-scale International Standards Organization (ISO) 9705 Room/Corner Test is currently used to regulate compartment-lining materials in the High Speed Craft (HSC) Code. This test method involves the use of large amounts of material so that the test method is an impediment in developing new materials. Bench-scale tests like the Cone Calorimeter and the Lateral Ignition Flame Test (LIFT) Apparatus may provide indications of full-scale performance in the ISO 9705. The objective of this work is to assess if correlations and mathematical models based on bench-scale data can predict material performance in the ISO 9705 Test.

The results of this project show that it is possible to learn a great deal about the expected performance of materials in the ISO 9705 Test from bench-scale tests like the Cone Calorimeter and the LIFT Apparatus. Both the simple correlations using the Flammability Parameter deduced from the Cone Calorimeter and the mathematical models using Cone Calorimeter and LIFT data provided clear insights into the burning behavior of materials in the ISO 9705 Test.

The Flammability Parameter deduced from Cone Calorimeter data was able to correlate the heat release rate and time to flashover in the ISO 9705 Test. This provides the opportunity to obtain significant information concerning expected ISO 9705 performance from a few tests of small samples. It is significant that LIFT results are not required to allow correlation of the performance of U.S. Coast Guard (USCG) HSC Materials.

The mathematical models performed well in predicting the heat release rate and time to flashover in the ISO 9705 Test. These more sophisticated methods provide additional confidence in the ability of bench-scale tests to be used to predict the performance of materials in the ISO 9705 Test. Further, these models have the potential to allow prediction of realistic scenarios, which differ from the ISO 9705 Test method.

Neither correlations from the Cone Calorimeter nor the mathematical models adequately predict the smoke generation rates in the ISO 9705 Test. The inability to predict smoke generation is particularly significant for materials that pass the heat release rate criteria in ISO 9705. Significant additional work is needed in this area.

Volume I of this report contains the objectives, approach, test results, and conclusions. Volume II consists of three appendices; a) prediction based on Quintiere's model; b) evaluation of Worcester Polytechnic Institute (WPI) zone model, and c) Hughes Associates/U.S. Navy Corner Flame Spread model and comparison with USCG ISO 9705 Test results.

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EXECUTIVE SUMMARY

The U.S. Coast Guard has responsibility for ensuring adequate safety for passengers and crew onboard commercial vessels. They accomplish this by establishing and enforcing construction and operating regulations both domestically and internationally. The International Code of Safety for High-Speed Craft (HSC Code) is a regulation that addresses safety concerns onboard high-speed craft and was prepared to allow new types of ship construction for fast sea transportation, while maintaining a high degree of safety for passengers and crew.

In accordance with the HSC Code, only materials that pass the International Standard Organization (ISO) 9705 Room/Corner Test may be used as compartment linings. This test generally consists of lining the ceiling and walls of a standard size room, exposing the corner of the room to a fire and evaluating how much heat and smoke are produced over a defined time period. Large quantities of the test material are required, so manufacturers of these materials are reluctant to pursue development of new and improved products. If a test method that did not require such large quantities of material could be used for regulation, manufacturers would potentially be more inclined to develop improved products. Additionally, a simpler (i.e., small-scale) test method would make regulation by the U.S. Coast Guard easier to accomplish.

Reliable and accurate prediction of full-scale performance from small-scale testing is a concern in the area of fire safety. The work documented in this report was conducted to see just how well the ISO 9705 Test results could be predicted from results obtained from small-scale test methods. This was a first step toward the goal of using a small-scale test method as a regulatory tool. Three separate fire research organizations used the Cone Calorimeter and LIFT Apparatus as two small-scale tests to evaluate the degree of predictability of large-scale test results for several materials.

Simple correlations including Flammability Parameters (FP) were deduced from a combination of Cone Calorimeter results and mathematical model results, which used Cone and LIFT data. The correlations provided valuable insight into which materials would easily pass or definitely fail the flammability criteria in the ISO 9705 Test. However, there is a range of FP values that do not provide adequate indications of how the materials would perform in the full-scale test. Additionally, there is a smoke production criteria in the ISO 9705 Test which neither the correlations, nor the mathematical models, adequately predicted. Significant additional research is needed in this area to adequately predict large-scale smoke production results from small-scale tests.

As discussed above, additional research is required to reach the goal of relying on small-scale test results for regulatory purposes. However, the research completed in this study clearly indicate that manufacturers

can benefit from evaluating new materials in small-scale tests prior to investing in larger quantities of materials for the large-scale ISO 9705 Tests.