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FULL-SCALE TESTING OF WATER MIST FIRE SUPPRESSION SYSTEMS FOR SMALL MACHINERY SPACES AND SPACES WITH COMBUSTIBLE BOUNDARIES – VOLUME I	October 1999
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15. Supplementary Notes

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16. Abstract (MAXIMUM 200 WORDS)

This report provides an evaluation of the firefighting capabilities of the state-of-the-art water mist fire suppression systems in smaller (~ 100 m^3) machinery space applications. The primary objective of this investigation was to evaluate the applicability of the International Maritime Organization's (IMO) test protocol and design requirements to smaller machinery spaces and to machinery spaces with combustible boundaries. The following water mist systems were included in this evaluation: Chemetron CFS, Fike Micromist, Grinnell AquaMist, Fogtec Fire Protection Systems, and the U.S. Navy's water mist system.

The five water mist systems were each capable of extinguishing a majority (at least nine out of fifteen) of the test fires included in this evaluation. Variations in system capabilities were observed primarily during the tests conducted with forced ventilation. Machinery spaces with combustible boundaries were shown not to pose a significant challenge to the water mist systems. The results of these tests suggest that the current IMO design requirements can be reduced for smaller machinery spaces. The amount of reduction needs to be determined on a case-by-case basis. An approach for defining the protection requirements (i.e., duration of protection) for these smaller machinery spaces is also described in this report.

The report and Appendix A (Instrumentation and Camera Details) are contained in Volume I. Volume II consists of Appendix B (Test Data) and Appendix C (Combustible Boundary Test Data). Appendices B and C are available in paper copy only from the Research and Development Center.

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EXECUTIVE SUMMARY

The firefighting capabilities of the state-of-the-art water mist fire suppression systems were evaluated in smaller (~100 m^3) machinery space applications. The primary objective of this investigation was to evaluate the applicability of the International Maritime Organization's (IMO) test protocol and design requirements to smaller machinery spaces and to machinery spaces with combustible boundaries.

In December 1994, the IMO Maritime Safety Committee approved guidelines for alternative arrangements for halon fire extinguishing systems (MSC Circular 668) [1]. Annex B of the guidelines provides an interim test method for evaluating equivalent water-based fire extinguishing systems for Category A machinery spaces and cargo pump rooms. Since the development of these guidelines, numerous research programs [2, 3, 4] have demonstrated that a properly designed and tested water mist fire suppression system can provide effective protection of Category A machinery spaces. These tests have suggested that smaller spaces should be easier to protect due to water mist's dependence on oxygen depletion to extinguish obstructed fires. The concern for these smaller spaces is whether any of the strict design requirements for larger spaces (i.e., duration of protection) can be reduced to achieve a lighter, less costly system.

Machinery spaces regulated under Sub-chapter T and K of Title 46 of the Code of Federal Regulations and IMO's High Speed Craft (HSC) code may be constructed with combustible boundaries. Therefore, combustible boundaries needed to be evaluated in assessing the extinguishment capabilities of water mist fire suppression systems in smaller machinery spaces. The goal of this effort was to determine appropriate protection requirements for smaller spaces and spaces with combustible boundaries. This work was performed under a research and development project for the Life Saving and Fire Safety Standards Division (G-MSE-4) of Coast Guard Headquarters.

The fire suppression capabilities of five commercially available water mist systems (Chemetron, Fike, Grinnell, Fogtec, and the U.S. Navy's water mist system) were evaluated in a machinery space with nominal dimensions of 5 m x 7 m x 3 m using three ventilation conditions (closed compartment, a naturally ventilated compartment with a 1.7 m^2 vent opening, and a compartment with forced ventilation 25 m^3/min). The five water mist systems were each capable

of extinguishing 9 out of 15 of the test fires included in this evaluation. Degradation in the performance of each system's capabilities was observed primarily during the tests conducted with forced ventilation.

A steady state extinguishment model developed during a previous investigation was used to analyze and explain the results of these tests. The model was used to predict the critical fire size for the three ventilation conditions included in this evaluation. The critical fire size is defined as the smallest fire that will reduce the oxygen concentration in the space due to consumption of the oxygen by the fire and a dilution of the oxygen with water vapor to the Limiting Oxygen Index (LOI) of the fuel. These critical fire size predictions helped explain which fires could not be extinguished.

The model was capable of accurately predicting the steady state compartment temperatures and extinguishment times for the spray fire scenarios but had difficulty predicting the results of the pan fire scenarios. Throughout this test series, the pan fires were more difficult to extinguish than spray fires of a given size. This is believed to be the result of a reduction in burning rate caused by the lower oxygen concentrations in the space. If a reduced burning rate (50 percent of the estimated ambient value) is used in the model, the predictions become similar to those measured during the tests.

Three of the water mist systems were tested against three different boundary materials to evaluate performance of water mist technologies against combustible boundaries. The initiating spray fire used during these tests (250 kW) was one of the more difficult fires to extinguish during the system capabilities evaluation. However, this initiating fire was sufficient to ignite a significant amount of the combustible boundary material. The combustion of the boundary material increased the fire size (higher heat release rate) making them easier to extinguish. Consequently, all of the combustible boundary fires were extinguished during this evaluation. In only one test did fire burn through the combustible material. This test with its unexplainable variance was viewed as an anomaly in the data, and is believed not to alter the conclusion. In general, combustible boundaries do not pose a significant challenge to water mist systems.

The final objective of this investigation was to determine if the current system design requirements (primarily duration of protection) can be reduced for water mist systems applied to

smaller machinery spaces. This would result in a lighter, less costly system. The results of these tests suggest that the current IMO design requirements can be reduced for smaller machinery spaces. The amount of reduction needs to be based on the size/volume of the protected area, as well as on the ventilation conditions in the space. An approach for determining these requirements is also described.