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**An Evaluation of Aerosol Extinguishing Systems
for Machinery Space Applications:
Flame Guard Test Results**

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Figure 10. Typical Fire Temperature History.

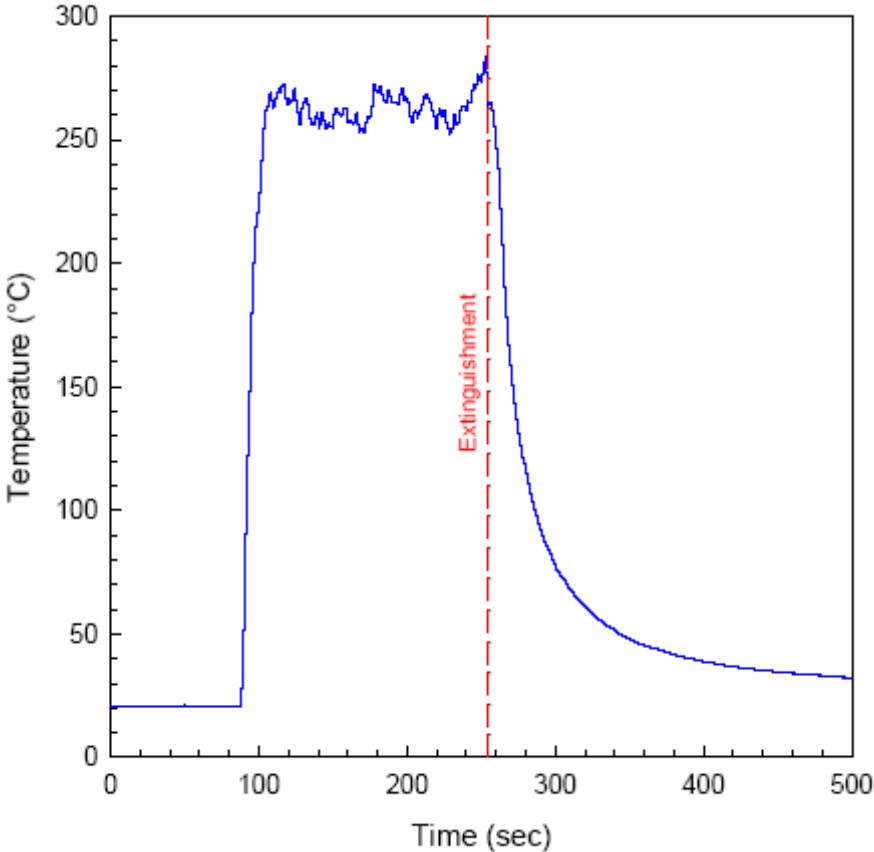


Figure 11. Compartment Conditions.

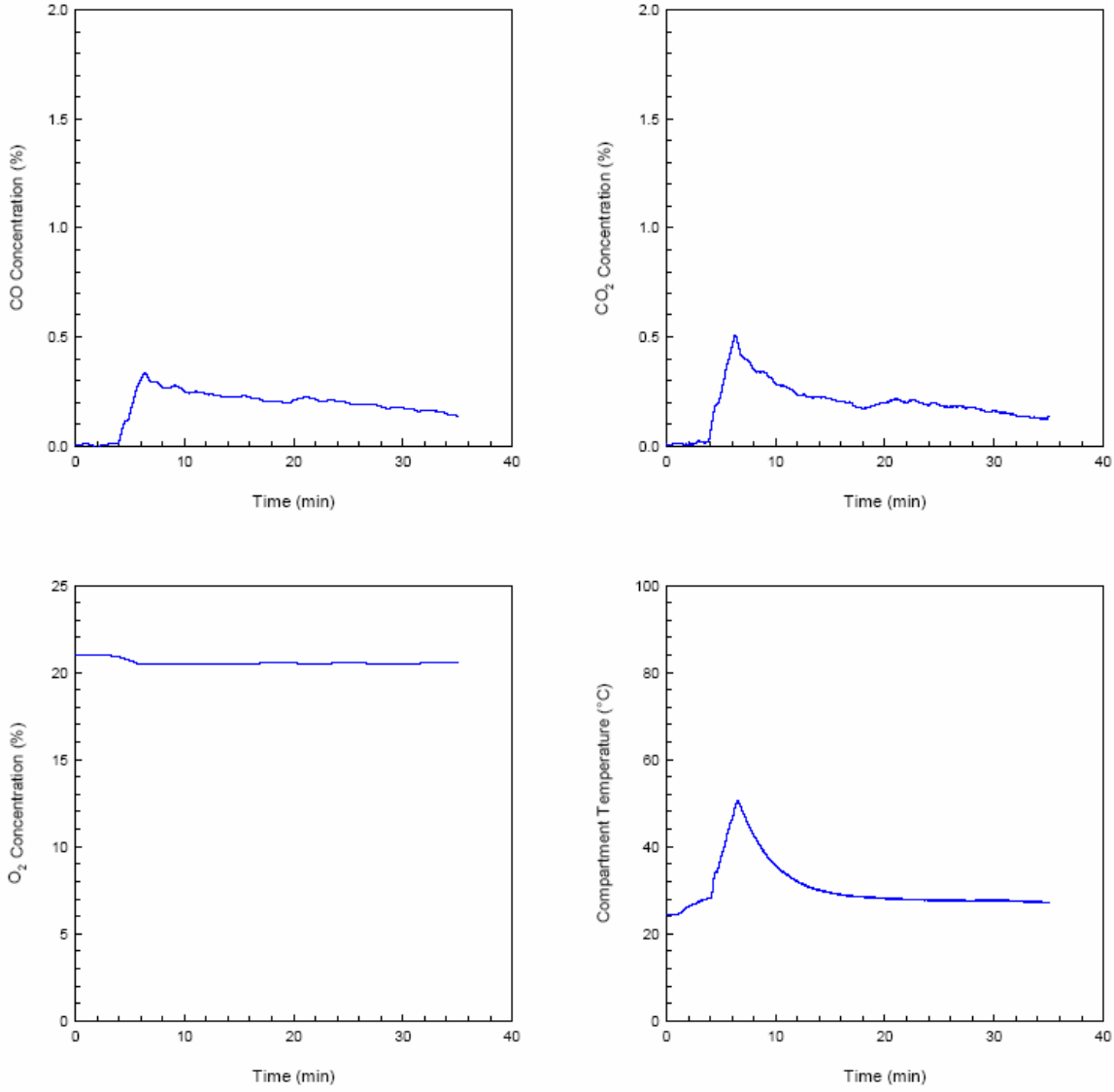
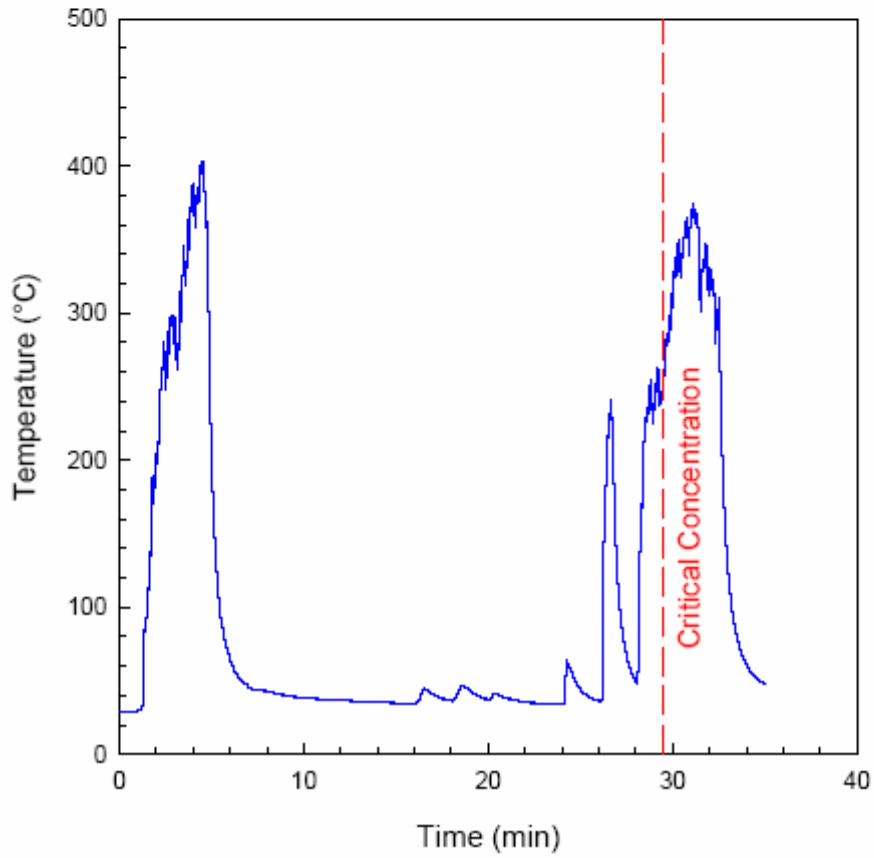
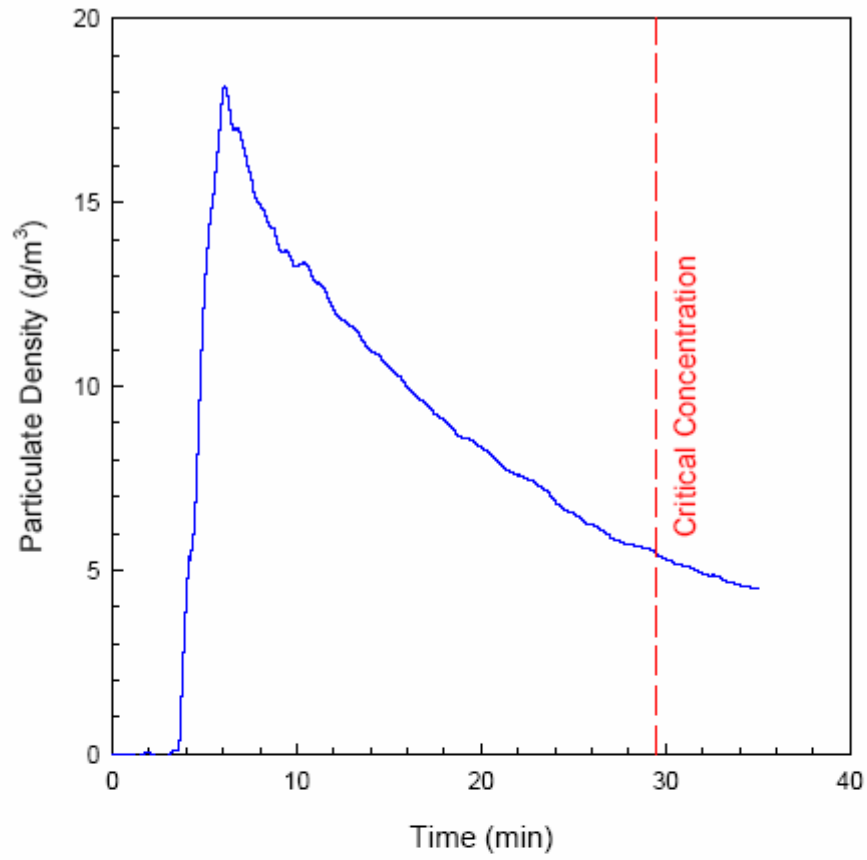


Figure 14. Reignition Test Results.



7.0 SUMMARY

A total of 18 tests were conducted in this evaluation utilizing the equipment from three AES manufacturers (Ansul, FirePro and Flame Guard). Each manufacturer was responsible for the design of their respective system. The delivered densities of these systems ranged from about 45-150 g/m³. The systems were tested against the current International Maritime Organization's (IMO) test protocol for approving aerosol extinguishing systems for machinery space applications (MSC/Circ. 1007, Guidelines for the Approval of Fixed Aerosol Fire-Extinguishing Systems Equivalent to Fixed Gas Fire-Extinguishing System"). The results of the five tests conducted using the AES manufactured by Flame Guard were discussed in this report.

The conditions produced by the discharge of the AES (and discussed in the following paragraphs) were measured during the telltale fire tests that were conducted at a lower design density than would be used in an actual installation. As a result, these conditions need to be scaled based on the design density used in the final system design.

The aerosol is discharged as a hot white smoke that reduces the visibility in the space (to about 0.3 m assuming an illuminated source/target) and increases the temperature (on average about 25°C above ambient). The temperature of the agent as it exits the generator is typically hundreds of degrees Celsius. As a result, combustible materials should be kept at least 0.7 m away from the generator while the safe distance for humans is about 1.6 m.

The gas concentrations (CO, CO₂, and O₂) in the space are also effected by the agent/system discharge. More specifically, the system with a delivered density of 59 g/m³ produced the following gas concentrations in the space: CO-0.35%, CO₂-0.5% and O₂-20.5%. These effects should scale proportionally with delivered density.

The particulate density produced during the telltale fire test (Scenario 1) was determined to be about 18 g/m³. This is only about 30% of the mass of the agent discharged by the generators. The remaining 70% is discharged as a gas containing various amounts of CO, CO₂, H₂O, and N₂.

The particulate density was shown to decay at a rate of about 3% per minute (even in a well sealed space). As a result, the particulate density typically decays by over 60% during the 15-minute agent hold time period required in MSC/Circ. 1007.

Although the particulate density decayed over time, the systems had no problems meeting the hold time requirements. The critical particulate density (the density below which reignition of Class B fuels can occur) was identified to be on the order of 6 g/m³. This is approximately onethird of the peak particulate density produced by the system. As a result, the system provided reignition protection of Class B fires/fuels for about 23-minutes after the end of agent discharge. This would be even longer for higher design densities used in an actual installation.

With respect to the extinguishment capabilities of the system, the system exhibited excellent capabilities against Class B fires, but had difficulty extinguishing the Class A fires. Further testing is recommended to determine if the Class A fires (wood cribs) could be extinguished with a higher design density.