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15. Supplementary Notes The R&D Center's technical point of contact is Brian Dolph, 860-441-2817, of the U.S. Coast Guard Research and Development Center. The Project Officer is LCDR Kevin Harkins, Coast Guard Atlantic Area (Aof).					
16. Abstract (MAXIMUM 200 WORDS) This report documents the results of a fire safety analysis of the USCGC DEPENDABLE prior to and after implementing changes associated with the Paragon project. The Paragon project reduces the normal crew by approximately 20% and implements a number of changes to supplant the loss of manual firefighting effectiveness. These changes include a new fire detection and monitoring system, installation of fixed surveillance cameras, and utilization of a rapid response team concept. The Ship Fire Safety Engineering Methodology (SFSEM) and associated computer program, SAFE version 2.2, were utilized as an analytical tool to perform the analysis. The SFSEM is a probabilistic based fire risk analysis methodology. It is useful to conduct a structured and comprehensive analysis of the performance of all types of surface ships as a fire safety system. The SFSEM provides an integrated framework for analyzing fires on ships in comparison to established fire safety objectives. It accounts for all relevant aspects of fire safety including the growth and spread of fire, the effectiveness of passive design features such as barriers, and active fire protection features such as fixed and portable fire extinguishing systems, as well as manual fire suppression. SAFE implements the SFSEM and evaluates the probability of spaces and barriers limiting a fire. The evaluation is conducted on a compartment-by-compartment basis. SAFE calculates the probable paths of fire spread for user-specified time duration. SFSEM/SAFE has been successfully used to analyze the fire safety design of existing as well as proposed ships. SAFE input data included information collected during a ship visit to the CGC DEPENDABLE during the period 30 September – 3 October 1997. Baseline fire safety analysis results show that with just passive fire protection in effect (without considering automated or manual fire protection), all compartments in the DEPENDABLE exceed fire safety objectives, both in port and at sea. Automated and manual firefighting attributes increase the margin of safety provided by passive protection. The post Paragon fire safety analysis shows improvement in fire safety in all scenarios. Recommendations are provided to implement the rapid response team concept on all other cutters in the Coast Guard and modification of fire detection systems on other cutters.					
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EXECUTIVE SUMMARY

The Coast Guard commenced the Paragon Project to more effectively and efficiently operate a 210' WMEC in all mission areas, with an eye cast toward opportunities for crew-size reduction. The USCGC DEPENDABLE (and crew) was selected as the test vessel to evaluate this new operational philosophy. The Coast Guard is evaluating all aspects of operating DEPENDABLE with a reduced crew, including effects on fire safety, watchstanding, maintenance, and mission performance. The objectives of this study are to perform fire safety analyses of fire protection levels of pre-Paragon and post-Paragon conditions on board DEPENDABLE to ensure that an acceptable level of fire safety is achieved in both configurations. The scope of this project includes a comparison of results of these analyses.

The Ship Fire Safety Engineering Methodology (SFSEM) and associated computer program, SAFE version 2.2, were utilized as an analytical tool to perform the analyses. The SFSEM is a probabilistic-based fire risk analysis methodology. It is useful to conduct a structured and comprehensive analysis of the performance of all types of surface ships as a fire safety system. The SFSEM provides an integrated framework for analyzing fires on ships in comparison to established Fire Safety Objectives (FSO). It accounts for all relevant aspects of fire safety, including the growth and spread of fire, the effectiveness of passive design features such as barriers, and active fire protection features such as fixed and portable fire extinguishing systems as well as manual fire suppression.

SAFE implements the SFSEM and evaluates the probability of spaces and barriers limiting a fire. The evaluation is conducted on a compartment-by-compartment basis. SAFE calculates the probable paths of fire spread for a user-specified time duration. SFSEM/SAFE has been successfully used in the past to analyze the fire safety design of existing as well as proposed ships.

SAFE input data for the pre-Paragon analysis included information collected during a ship visit to the DEPENDABLE during the period 30 September to 3 October 1997. The baseline (pre-Paragon) fire safety analysis results show that all compartments in the pre-Paragon DEPENDABLE exceed FSOs, in port and at sea. Moreover, all compartments exceed FSOs with just passive fire protection in effect. Automated fire protection systems and manual firefighting efforts serve to increase the margin of safety provided by passive fire protection. This means that no improvements are necessarily required to bring the pre-Paragon DEPENDABLE up to minimally acceptable fire safety levels.

The following changes associated with the Paragon project were implemented on DEPENDABLE:

- The original zoned fire detection system was changed to a fully addressable system.
- Sixteen fixed surveillance cameras were installed in strategic locations throughout the vessel. TV monitors located throughout the ship constantly display the view from one of the cameras.
- The fire detection and monitoring system is integrated with other alarms, including bilge high water level and magazine high temperature. The system is also integrated with the surveillance cameras, TV monitors mounted in strategic locations, and the general announcing system. The system is designed to automatically make an announcement of the precise location of a fire as soon as it is detected. In addition, the nearest surveillance camera automatically locks in so that all TV monitors provide a continuous view of the scene near the fire.
- A four- to five-person Rapid Response Team (RRT), modeled after a concept developed by the Navy, is used to immediately respond to all fires in port and at sea.
- At sea and in port, away from homeport, one repair party is billeted to be manned (as compared with two repair parties in other 210' WMEC cutters).
- In homeport, the normal duty section is reduced to five persons. Reliance is placed on the assistance available from the city fire department as well as from other cutters that may be in port at the time.
- Most crew members have been issued personal portable wireless communication devices.

Some of the changes implemented on DEPENDABLE as a result of the Paragon Project increase the fire safety of the cutter, while other changes have an adverse effect on fire safety. The net effect on the fire safety of the DEPENDABLE as a result of the Paragon changes is significantly positive or beneficial for all scenarios. The average increase in fire safety of the post-Paragon cutter compared to the pre-Paragon cutter varies from 15.3% for the in homeport, XRAY, scenario to 30.5% for the at sea scenario. The post-Paragon fire safety analysis results show that all compartments exceed FSOs, in port and at sea. Furthermore, all compartments exceed FSOs with just passive fire protection in effect. Automated fire protection systems and manual firefighting efforts serve to increase the margin of safety provided by passive fire protection. This means that no improvements are necessarily required to bring the post-Paragon DEPENDABLE up to minimally acceptable fire safety levels.

As a result of performing the fire safety analysis of the post-Paragon DEPENDABLE, the following recommendations are offered for consideration by the Coast Guard:

- Besides the obvious benefits in damage control and firefighting, the personal communication devices issued to virtually all crew members has benefits in many other aspects of operating the cutter. All Coast Guard cutters could benefit from issuing these devices to their crew members.

- The Coast Guard should consider revising the firefighting procedures in all cutters to incorporate a rapid response team concept.
- All cutters with a fire detection system that can be similarly modified as on DEPENDABLE should be changed to a fully addressable system.
- The new fire detection and monitoring system has not been fully implemented in DEPENDABLE due to technical difficulties encountered during installation. It is recommended that this system be fully implemented to take full advantage of the increase in fire safety offered by the new system.

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The appendices in this report include the AutoCAD drawings and comprehensive tables of input data used to populate the baseline data set in SAFE. The detailed spreadsheets for calculating the probabilities of flame termination are included as supporting data. The input and output data from the analysis of the post-Paragon DEPENDABLE are also included.

