Executive Summary
Damage Control and Maintenance

SCOPE

The Damage Control and Maintenance Panel of the Naval Research Advisory Committee (NRAC) was tasked by the Assistant Secretary of the Navy (Research, Development, and Acquisition), with the Commander, Naval Sea Systems Command (NAVSEA) as the study sponsor, to "identify science and technology opportunities as well as policy and process improvements, to reduce onboard manning for damage control and maintenance of in-service platforms." The Panel considered the "science and technology opportunities" of the Terms of Reference in the broadest interpretation, from mature and state-of-the-art to developmental. Moreover, while the study focused on "in-service platforms," most of its findings and recommendations are equally applicable to new construction, (e.g., LPD-17, SC-21, and ARSENAL SHIP).

STUDY APPROACH

The study panel consisted of 15 members from academia and industry, including retired flag officers with extensive operational experience, and also Royal Navy representation. The Panel heard briefings from a broad cross section of the Navy's technical community on the topics of manning, damage control, and maintenance and visited several operational platforms and numerous installations, including several firefighting and damage control training facilities, the USS *Yorktown* , and the ex-USS *Shadwell* óthe Navy's principal Research and Development (R&D) firefighting facility. The Panel also reviewed both the recent experience of the Royal Navy in their reduced manned Type 23 Frigate and the operational characteristics of Israel's SAAR-5.

FINDINGS

Ship Manning

As documented in 1995, the NRAC study on "Life Cycle Cost Reduction" revealed that the major cost of ownership of ships is incurred during the operation and support phase of the life cycle. During this phase, the dominant cost driver is manning, but reducing manning impacts the complex relationship of manpower requirements for operating, maintaining, supporting, fighting, and saving the ship. A rational approach to reducing manning requires a systems engineering approach with in-fleet demonstration of proof-of-principle.

Smart Ship

The object of the SMART SHIP program is to systematically evaluate an operational platform (USS *Yorktown*) in all aspects of shipboard manning with a goal of significant reductions. The program includes the review of warfighting requirements, watch

standing, preventive maintenance, damage control, and the introduction of technology to reduce manning requirements. In the judgement of the Panel, the SMART SHIP program has adopted a realistic approach with appropriate emphasis on damage control and maintenance and technology insertion. Currently, the SMART SHIP is evaluating a reconfiguration of the Damage Control Organization and procedures, which reduces damage control personnel from 125 to 61, and a reduction in preventive maintenance tasks by 30 percent.

Damage Control

Although damage control requirements are not the controlling factor in determining ship manning today, the manning difference between operating the ship (Condition III) and fighting the ship (Condition I) is marginal. However, the damage control requirements of fighting hurt will be the limiting factor in determining the crew size of in-service ships as well as new ships with more automation and less maintenance. Indeed, the emphasis on SMART SHIP is in reducing damage control personnel. In the next DON major ship acquisition, LPD-17 requires an additional 28 billets more than Condition III for damage control manning. The realization of reduced manning on in-service and/or new ships will require the crew to receive superior training and to be supported by user-friendly, capability-enhanced damage control equipment, and significantly improved communications and situation awareness capabilities. Technology opportunities include: replacing the Oxygen Breathing Apparatus (OBA) with Self-Contained Breather Apparatus (SCBA); replacing the Naval Firefighting Thermal Imager (NFTI) with the helmet-mounted infrared visor; incorporating the Hierarchical Yet Dynamically Reprogrammable Radio (HYDRA) and situational awareness systems like the Damage Control System (DCS), the Standard Monitoring and Control System (SMCS), and Integrated Condition Assessment System (ICAS). It is also the unanimous judgement of the Panel that the issue of affordable sensors for situational awareness falls into the category of critical enabling technology for reduced manning on both in-service and new ships.

Maintenance

Today's naval forces are faced with the existing Periodic Maintenance System (PMS), the availability and rapid influx of new technologies and a shrinking maintenance budget, (although an increased percentage of the DON's Total Obligation Authority). These maintenance-related issues were highlighted by various agencies during our study and reinforce several fundamentals about an efficient maintenance system as follows: it needs to look at function and not periodicity, i.e., it must be: (1) mission focused, (2) user friendly, (3) take advantage of emerging technologies and current knowledge, such as Reliability-Centered Maintenance (RCM), (4) consider life cycle costs during the acquisition of new ships, and (5) change the mindset from what "we have always done."

The Panel believes that the RCM methodology provides an enlightened approach to maintenance, determining what and when a maintenance action must be done while ensuring that any piece of equipment or system operates within its intended operational

parameters. This maintenance concept focuses on function and timely, educated interventions to maintain equipment and systems as opposed to PMS, which focuses on a schedule, creating a repetitious, labor-intensive, and in some cases unnecessary process that may do more harm than good to equipment. The PMS approach to maintenance leaves much to be desired, particularly when reduced manning and system sustained reliability are the goals. RCM is function focused, reliability based, and a less labor-intensive maintenance system that should therefore be pursued. This approach has the potential to reduce the maintenance burden by thousands of crew hours per week per ship.

Ship Status Sensor System

If manpower expended on maintenance and damage control is to be substantially reduced, the ability to remotely and reliably determine the real-time status of the ship and crew must be expanded far beyond the current capability. In virtually any damage control scenario, knowledge of the location and status of crew members is essential, from the standpoint of establishing damage control team capability as well as planning casualty rescue efforts. "Electronic dog tags," or communication through a wireless sensor telemetry system, could easily provide crew location information and could report a general summary of individual status (by displaying such knowledge of the status of various ship systems is also required. Current Navy systems such as DCS, ICAS, and the SMCS, provide the basis for performing situational awareness of the ship but are limited by the availability of affordable sensors.

MAJOR CONCLUSIONS

- SMART SHIP is one of the most innovative initiatives, to date, to establish the optimum composition of levels of shipboard manpower. It is the critical first step in reducing manning and must continue to be supported at all levels of the DON.
- A significantly smaller damage control crew will be a team with superior training, supported by timely situational awareness information, and outfitted with user-friendly, capability-enhancing damage control and communication equipment.
- Reengineering of the Navy's onboard maintenance policies and practices in accordance with current knowledge and emerging technologies will significantly reduce the manpower burden, saving thousands of crew hours per week per ship.
- The development of affordable sensors by utilizing micro-electromechanical systems (MEMS) and wireless telemetry has the revolutionary potential to reduce ship manning across the board for both in-service and future ships. An Advanced Concept Technology Demonstration (ACTD) investment should be made to realize these benefits.

MAJOR RECOMMENDATIONS

SMART SHIP

- Maintain:

    - Strong, visible, top-level Navy commitment
    - Stability of key personnel through rotation
    - Special funding basis beyond June 1997
    - Reasonable expectations
    - As a deployable asset
    - Active Navy technology community involvement
- Transition results into Fleet as soon as PROVEN... "ASAPr"

Damage Control

- Execute an acquisition and training master plan for the replacement and upgrade of damage control and communication equipment based on:
    - Systems approach
    - Approved organization changes
    - Operational requirements
    - Stable budget
- Develop alternative, more realistic firefighting training to better prepare shipboard firefighting personnel, e.g., private or ex-USS *Shadwell* -like facilities
- Incentivize repair party crew to maintain physical fitness, e.g., through in-fleet competitions

Maintenance

- Evaluate and modify, as appropriate, ship maintenance practices based on:
    - Available operational data
    - Feedback reports
    - Engineering analyses
    - Reliability-centered maintenance
    - Condition-based maintenance
- Insert cost-effective Commercial Off-The-Shelf (COTS) improvements as soon as PROVEN... "ASAPr"

Ship Status Sensor System

- A significant investment in micro-electromechanical systems with wireless telemetry for shipboard applications should be made now to realize the near-term benefit for retrofit to current ship inventory and to impact the pending new construction schedule.