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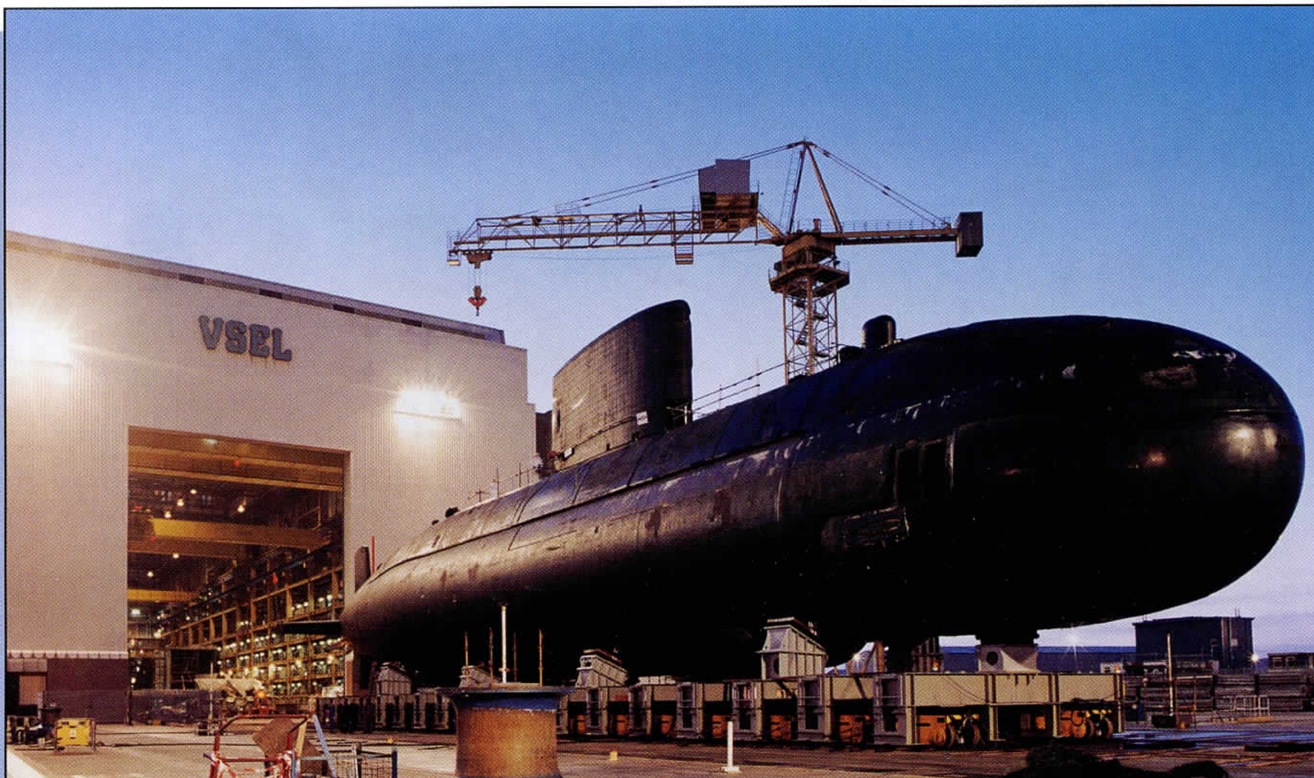
Maritime Engineering Journal

CANADA'S NAVAL TECHNICAL FORUM

Summer 2000



Submarine Safety Management: A MoD (U.K.) system offers a benchmark for Canada's new *Victoria*-class SSKs

Also in this Issue:

- *Maintenance Capability Study in HMCS St. John's*
- *CNTHA News: They "rolled on wet grass," but just how stable were Canada's steam destroyers?*

Canada

Do our technicians have enough time for maintenance? The engineers in HMCS *St. John's* validated what most people in the technical community already know —

DND photo by Réal Thibault

— The Maintenance Capability Study begins on page 17

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Cover:

As Canadian exchange officer LCdr David Peer sees it, the U.K. Ministry of Defence has a system worth investigating when it comes to submarine safety management. *(VSEL Barrow-in-Furness photo C/120/932/20, used with permission, courtesy PM SCLE)*

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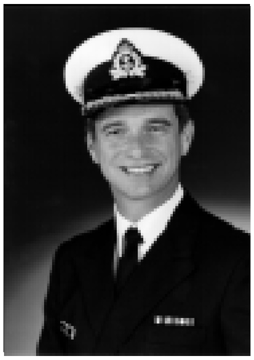


Editor’s Notes

The Most Important Word

By Captain(N) David Hurl
Director of Maritime Management and Support

Some time ago I had the opportunity to attend a Senior Review Board at which a project manager was seeking approval for a number of recommendations. The officer’s presentation was slick and technically accurate, and the risks he was describing were minimal, but as his presentation continued I began to feel increasingly ill at ease. It was only later, back in my office, that the reason for my discomfort became clearer.

On my office wall is a small plaque that my father gave me a number of years ago. It came from his glory hole in the basement. The inscription on the plaque reads:

A Short Course in Human Relations

the **six** most important words
“I admit I made a mistake”

the **five** most important words
“you did a good job”

the **four** most important words
“What is your opinion?”

the **three** most important words
“if you please”

the **two** most important words
“thank you”

the **one** most important word
“we”

the **least** important word
“I”

— Anonymous

Throughout his presentation the project manager had referred to *his* ideas, *his* progress, *his* plans, *his* success — always in the first person. He used the least important word repeatedly, entirely missing the most important one, “we.” Although the SRB approved the recommended options, the project manager without realizing it had risked “turning off” the interest of the very people whose support he was seeking. He had made his road rockier than it needed to be simply through the tone of his presentation.

I took the experience to heart. Sometimes, particularly in leadership positions, we forget to acknowledge that our success emanates from the combined hard work, dedication and abilities of the many individuals on the team. When you think of it, there’s not much in this business of naval support that is done exclusively by oneself. It was a good reminder to me to remember to always share credit with “the one most important word.”

The *Journal* welcomes **unclassified** submissions, in English or French. To avoid duplication of effort and to ensure suitability of subject matter, prospective contributors are strongly advised to contact **The Editor, Maritime Engineering Journal, DMMS, National Defence Headquarters, Ottawa, Ontario, K1A 0K2, Tel. (819) 997-9355**, before submitting material. Final selection of articles for publication is made by the *Journal*’s editorial committee. Letters of any length are always welcome, but only signed correspondence will be considered for publication.

If you would like to change the number of copies of the *Journal* we ship to your unit or institution, please fax us your up-to-date requirements so that we can continue to provide you and your staff with the best possible service. Faxes may be sent to: **The Editor, Maritime Engineering Journal, c/o DMMS, at (819) 994-8709.**

Commodore's Corner

Guest Commentary

Observations from the Bridge Window

By Rear-Admiral David Morse
Commandant, Royal Military College of Canada

I am very grateful to Commodore Sylvester for having sacrificed his ownership of this space for this one issue — all to permit an operator a soapbox!

As many of you know, I recently completed a year in command of the Standing Naval Force Atlantic, and would now like to use this opportunity to share some observations from a multinational "bridge window."

Let me first deal with new ships. All of us lament, I think, the long gap between Canadian naval building programs, and many have advocated a policy of continuous construction to meet both naval and industry needs. By observation there is another side to this coin which we must consider carefully. The two Canadian flagships were the oldest ships in SNFL, but easily the most capable — a direct connection between new and best was certainly not evident. Other nations with more vigorous shipbuilding programs continue to build ships before perfecting a previous class. New ships are built at the expense of paying off fully functional and relatively young ships. Our concentration on niche technologies, on the smart importation of best practices and ideas and the progressive introduction of capability — taking advantage of every dollar to build the best and most long-lived ship possible — is the right one. Similarly, we cannot afford to explore marginal technologies, attempt complex programs beyond our core competencies, or tackle projects without a thorough appreciation of through-life costs, human and financial.

The second observation is the impact of information technology. A radical shift in how we operate is just about to hit us. The excellent work of operational and engineering staffs provided me with the best communications suite I have ever had — a phone line and a modem. Without denigrating the importance of traditional radio spectrum communications, the key information is now only available on the Intra/Internet. After years of trying alternative means of transmitting textual messages, that requirement has gone and we must now cater to the need for text, graphics, video and audio. Our naval priorities which emphasized CANUS interoperability and C2IS (command & control and information systems) were key to keeping in step. For the future, the challenge is twofold:

• to concentrate on the information demand and trust the innovative momentum of the technology. We must accept that we will never own all the data essential to operational success, or be able to manage it ourselves. Information technology is

(Cont'd)

Maritime Engineering Journal Objectives

• To promote professionalism among maritime engineers and technicians.

• To provide an open forum where topics of interest to the maritime engineering community can be presented and discussed, even if they might be controversial.

• To present practical maritime engineering articles.

• To present historical perspectives on current programs, situations and events.

• To provide announcements of programs concerning maritime engineering personnel.

• To provide personnel news not covered by official publications.

Submission Formats

As a rule of thumb, major article submissions should not exceed about 1,800 words. The preferred format is MS Word, accompanied by a hard copy of the typescript. The author's name, title, address and telephone number should appear on the first page.

Please submit photos and illustrations as separate pieces of artwork, or as individual *high-resolution* electronic files, and remember to include complete caption information.

converging on the Intra/Internet and will allow commanders and staffs unprecedented access; and,

• to resist the tendency to "make a project" out of this change. The rate of information technology change will not permit a long string of project definition, design and development, experimental and advanced development modelling, or similar activities. A basic secure backbone, a rational plan for risk management, inboard information management integration and empowered staff are the keys to staying up with the USN.

The third significant lesson — the influence of the littoral — must be absorbed in the next generation of naval systems. The blue water is not the challenge in any warfare area. We must be able to influence operations over the land. This is a sensor, platform, weapon, procedural and cultural issue. Sensors must be able to operate effectively in a cluttered electromagnetic environment, compensate for radar and acoustic shadowing, use all parts of the EM spectrum, and be integrated in real-time with other onboard and offboard sensors. Aircraft, piloted and unpiloted, must be able to work close to targets of interest and the shoreline. Weapons must be of controllable lethality and must be employable with perfect discrimination. And all these systems must reach beyond the shoreline to integrate with other service systems and with non-military partners. While this sounds like an impossible bill, many of the capabilities are already in the fleet in some way or another.

The long-term, combined effort of the naval operational and engineering partnership provided SNFL with outstanding capabilities. But that is history. The success of the "next navy" will rest on our ability to maintain the pace of innovation and to select for the future, as we did for the past, the high-payoff investments in technology, in procedures and in people.

Thanks to RAdm Morse for a really excellent commentary. He raises some fascinating issues — shipbuilding policy, communications, and trends in operations and weapons, to name a few. The *Journal* would certainly welcome articles or comments from our readership on these topics.

The challenge of keeping pace with technology while maintaining a degree of configuration and financial control is a real one. As RAdm Morse knows, we in MEPM "make a project" out of everything, and find that useful in keeping us out of jail! Our processes have recently been streamlined somewhat, but more may indeed be required. Readers' thoughts on this would also be welcome. — **Cmdre J.R. Sylvester, DGMEPM**

Letters

Strapdown Inertial Navigation

As the R&D representative mentioned in conjunction with the NATO SINS development (*"Strapdown Inertial Navigation in the Canadian Navy," Maritime Engineering Journal, Spring 2000, page 12*), I can offer some additional information which may be of interest.

The NATO SINS project comprised four nations: Canada, the Netherlands, Spain and the United Kingdom. Four companies bid for the development of the system with a Ferranti division (soon to become part of GEC-Marconi) in the U.K. submitting the winning bid. Their prime subcontractor was Sperry Marine (now Litton-Marine Systems). Following development, 55 systems were purchased by the other three nations. At the same time, Sperry, being aware of an ongoing USN requirement, designed a variant of NATO SINS without the Ferranti components. This became the Mk-49 system. The first customer was the ANZAC frigate program, quickly followed by USN purchases. Then came Canada.

During the passage of the NATO SINS project, Canada contributed a share of the development and project office costs and trialled one of the candidate systems, the Litton Canada WSN-5L, on board CFAV *Endeavour*. An added bonus of participating in the project was the undertaking of the USN that all project members would have access to high accuracy ring laser gyros built by Honeywell in Minneapolis. Tests of NATO SINS systems revealed a system accuracy over twice that specified by the NATO staff requirement. Canadian Mk-49 systems should thus demonstrate this level of accuracy as well.

A final note: The U.K. had an option to purchase an additional eight systems for fitting in their *Upholder* submarines. When they were laid up, this option was cancelled, leaving the submarines with an obsolete INS, the SINS Mk-2, I believe. **— Pat Barnhouse, ADM(S&T), DSTM 3, NDHQ Ottawa.**

(Letters continue on page 23)

New Ship Manning Reductions — Have we got it wrong?

Article by LCdr Peter Egener

The Directorate of Maritime Ship Support is currently engaged with the Directorate of Maritime Policy and Project Development in providing input to the Statement of Requirement for the Afloat Logistic Support Capability Project (ALSC). A significant requirement of this project is that manning levels must be substantially reduced from that of the AOR-509 *Protecteur*-class. At the same time, DMSS is involved with the Directorate of Maritime Strategy in defining the preliminary options analysis for CADRE — a potential Command and Control and Area Air Defence Replacement vessel. Here, too, manning targets have been set well below those for current ship classes. While warship manning reductions are a reasonable objective of many of the world's navies, I am gravely concerned (with respect to ALSC specifically, at this point) that we are proceeding in a haphazard manner. It would appear that we have not done the homework that is required to enable future manning reductions.

So far as I am aware, no studies have been conducted by the navy to define how our existing shipboard organizations must evolve to achieve the reduced manning targets. These targets simply cannot be met without significant changes to these organizations, yet despite this lack of a clear road map DMSS completed its input to the ALSC Statement of Requirement (SOR) last March.

The purpose of this paper is to outline my concerns with respect to how the navy appears to be addressing manning reduction for future ship classes in general and ALSC specifically. I will also describe the essential steps that I believe must be taken to ensure that manning targets can be achieved in a way that is acceptable to the navy. While this paper is written from the perspective of a Marine Systems Engineer, and the issues raised here focus on concerns with engineering watchkeeping and damage control, the issues will certainly be relevant to all shipboard departments as they affect special sea dutymen, bridge/ops room manning during action states,etc.

Doctrine vs. Technology

Not so long ago, technology, or the lack thereof, played a significant role in defining the number of watchkeepers that were required to operate shipboard equipment and man shipboard organizations. Automated systems capable of carrying out the tasks done by sailors were either unavailable or unproven. Today, however, technology exists that will allow a ship to be operated entirely from the bridge by one person with, perhaps, a handful of watchkeepers on call. Even damage control could be entirely automated through the use of remote fire-detection/suppression systems, etc. But having the ability to do something is not the same thing as actually doing it. Automation to this degree would almost certainly not be acceptable to the navy. A warship requires flexibility in its manning to cope with its varying roles, including dealing with equipment failures and battle damage with as little disruption to operations as possible. Of necessity, the naval environment has historically managed many aspects of its shipboard risk management through the development of organizations which, particularly in action states, are highly manpower intensive.

"...the navy would first have to determine its own comfort level with an entirely unmanned machinery control room..."

While technology can clear the path for reduced manning in future classes of ships, the actual target levels will be dictated by naval doctrine. The navy must make a conscious decision about how its future ships should be operated — which tasks can be automated and which must be done by sailors — and then define how existing shipboard organizations need to evolve to become less manpower intensive. In all likelihood, proven technology will be available to support any choice the navy makes. A study conducted by the USN's Naval Research and Advisory Committee concluded that, "the major obstacle to reduced manning was Navy culture and tradition, not the lack of proven technology."

Naval Occupations and the ALSC SOR

A substantial reduction in the number of shipboard billets will no doubt affect naval occupations. In addition to careful analysis of how the shipboard organizations must change to satisfy manning reduction requirements, consideration should also be given in advance to the impact these changes will have on the existing occupations. In the case of the Afloat Logistic Support Capability Project, although the total number of sailors on the three ALSC vessels will not change from the total complement of the two AORs, the number of sailors in each occupation will likely change. The impact that this will have on the naval occupations needs to be addressed.

As well, the skills required by each occupation to operate and maintain these future ship classes will likely be different from the skills that are required in today's fleet. In the case of the Mar Eng occupation, it is certainly realistic to expect that the balance between the operator and maintainer roles will change. The effect of this on the occupation structure, career progression and training should at least be considered before approaching industry with a Statement of Requirement in hand.

A detailed manning study has yet to be conducted for ALSC, and no decisions have been made yet about how shipboard organizations must change to enable the established manning targets. Despite this lack of critical analysis of shipboard manning, DMSS was tasked to provide input to the ALSC SOR to support the manning target levels. However, for systems that will play a critical role in enabling manning reductions to take place, providing input to the SOR at this point is not realistic when the shipboard organization these systems will be supporting has not even been defined.

Take, for example, the Platform Control Systems specification that was provided for the ALSC Statement of Requirement. It consisted of: "Maximize the level of automation to minimize the number of watchkeepers required." This is such a vague specification that an ALSC contractor could provide any number of solutions that would meet the specification. In effect, the contractor would be deciding for the navy how the navy will operate its ships. Until we decide how we should do things differently in the future, a more precise specification cannot be written.

Some fundamental questions need to be addressed before the Statement of Requirement can be written — such as whether both a Cert 2 and a Cert 3 engineer will continue to be required to operate the propulsion machinery, or if a single watchkeeper will be sufficient. A highly automated platform management system could even allow an on-call engineering watchkeeper only. But, again, the navy would first have to determine its own comfort level with an entirely unmanned machinery control room, and consider the impact this would have on the Mar Eng and E Tech/Mar El occupations. While it is unlikely the navy will be satisfied with a fully automated machinery control system, or for that matter a fully automatic damage control system, the point is that the choice of how far to go down this road must be a choice made by the navy *before* going to industry.

"In effect, the contractor would be deciding...how the navy will operate its ships."

While I have confined this discussion to engineering watchkeeping and damage control, manning considerations must also address the other significant drivers of Marine Systems manning — system maintenance and whole-ship evolutions such as RAS. There is little point in specifying a highly integrated machinery control system that can be operated by one person, if the maintenance concept for the ship requires a traditional number of first-line maintainers. These issues are fundamentally linked and must be considered as a whole.

Conclusion and Recommendations

The navy has established manning targets for future ship classes that are substantially below current ship class manning. It is not realistic to believe that these targets will be achieved within the constraints of the navy's existing manning policies and without adequate conviction to cause the changes required to naval culture. Despite this, the studies that will define how the shipboard organizations and naval doctrine must change in order to enable these manning reductions have yet to be carried out.

DMSS has already provided technical input to the ALSC Statement of Requirement. In tasking DMSS to provide input at this stage, a tacit assumption was made that *technology* would be the enabler that would allow the manning targets to be achieved. This assumption is incorrect. It is fundamental changes to existing naval doctrine and culture that will be the manning reduction enablers. The technology will be available to support any organizational choices the navy is likely to make.

Before proceeding any further with the technical definition of new ship classes, the navy must make some clear choices about how it wants to operate these ships. Recognizing that all naval ships of the future will be manned with fewer sailors, naval staff need to conduct a critical review of the shipboard organizations to establish a compromise between automation and manning that the navy is prepared to accept. Fewer sailors and more technology implies greater risk. How much risk is acceptable is a choice the navy must make.

Armed with the results of such a review, manning studies specific to each new class must be conducted to determine how the new doctrine will apply to the ships of that class, department by department, organization by organization. Ultimately, that is how the manning targets will be reached.

LCdr Egener is the DMSS 4 project manager for Integrated Machinery Control System projects.

An Overview of Submarine Safety Management in the U.K. MoD

Article by LCdr David Peer

The safety of Ministry of Defence (MoD) shipping activities, and especially submarines, has a very high profile in the United Kingdom. The Secretary of State for Defence requires safety management to begin at the first consideration of a new vessel and continue through design, construction, service and disposal. Safety management includes all aspects of in-service maintenance and operation including military service.

MoD established the Ship Safety Board and a Ship Safety Management System in response to the Secretary's requirement. The Ship Safety Board sets policy for MoD and authorizes and directs changes to the Ship Safety Management System when necessary. It also advises the Secretary of State, single-service chiefs, and the Chief of Defence Procurement on safety management matters. The Ship Safety Board is chaired at the vice-admiral level and has senior civilian and military representatives from all areas of MoD and the Royal Navy with a ship safety interest.

By definition, safety is a line management task within the design authority structure; only line managers in the design authority have the necessary responsibility and authority over the ship material state. *Figure 1* shows the interfaces between management groups for ship safety, and indicates information flow for policy and guidance, communication of standards, delegation of safety tasks, provision of resources, and audit. The Ship Safety Management Office is an executive arm of the Ship Safety Board and is the focal point within MoD for the management of ship safety. The Ship Safety Management Office sponsors MoD's policy document, JSP 430 — the *MoD Ship Safety Management Handbook*.

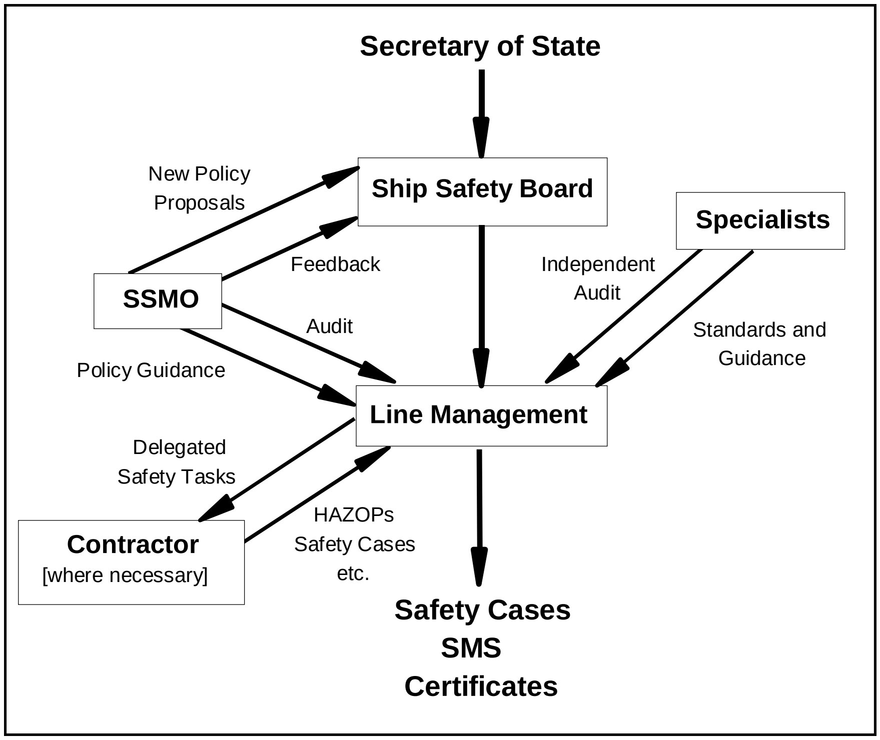


Fig. 1. Ship Safety Management System Interfaces

Specialist authorities are responsible for establishing and maintaining adequate safety standards and procedures; giving guidance on their application to specific tasks and hazards; and advising on the effect of shortfalls. Specialist authorities also provide a source of expertise for review and audit of safety documentation and Certificates of Safety.

The policy and principles of the Ship Safety Management System are defined in JSP 430; they cover all MoD-owned and -operated vessels. The SSMS encompasses all components of MoD ships including weapon stores; hull, marine and combat systems; ship-specific land-based training systems and equipment; and software. The SSMS demonstrates how MoD will meet all extant safety and health regulations including, as far as is reasonably practical, those specific regulations, health and safety standards and arrangements for which MoD has exemption.

The framework of the Ship Safety Management System includes requirements for responsible authorities, safety cases, safety management systems and ship safety certificates for "key hazard" areas. Though ultimately everyone has a responsibility for safety, "responsible authorities" controlling design and operation implement the Ship Safety Management System for in-service vessels.

Ship Safety Management System

The MoD design authority and the Royal Navy (RN) have comprehensive safety management systems that respond to the policy in JSP 430.

Both organizations have manuals describing systems in their respective areas of responsibility. The systems are complementary, but not centrally co-ordinated. For example, the RN Fleet Officer Submarines (FOSM) focuses on submarine operations, while the design authority focuses on the material state. The RN Safety Management System depends on the design authority providing a submarine with a material state safe for the operational role.

The retrospective introduction of safety management systems created a problem for existing ships and submarines. MoD design authorities lack "safety cases" for existing vessels and design histories are often incomplete. A compromise for existing designs demonstrates a satisfactory material state by comprehensive safety assessments in combination with years of successful operation.

JSP 430 recognizes that implementing a safety management system for existing vessels is difficult and comes at the cost of scarce resources. MoD policy permits partial and staged implementation of a safety management system. For new ship projects the full requirements of JSP 430 apply. A safety case is not mandatory for existing ships unless changes in design requirements or in the use of a vessel raise significant new hazards. However, the design authority must carry out a safety assessment for existing ships in sufficient detail to highlight all known key hazards.

This paper will explore the MoD submarine design authority's safety management system and the processes that are in place to ensure that the material state of submarines is safe for all operational roles. But first, the role of safety assessments, the safety case and safety certification in the Ship Safety Management System need explanation.

Safety Assessments

Where the requirements of JSP 430 do not demand a full safety case, the design authority is responsible to conduct a safety assessment. The safety assessment is less complete than a safety case as it recognizes that some essential information on the material state may not be available. Safety assessment is a collective term used to identify a group of safety assessments on critical equipment and systems; it does not typically exist as a single document. Appropriate design authority sections with responsibility for equipment or systems hold the component safety assessments. As a minimum a safety assessment must include sufficient detail to describe:

"The changes AIP brings to the Upholder class would require at least a limited safety case because of significant changes to the original design intent."

- **design criteria*;
- **standards used in design and decisions relevant to safety (if available)*;
- **information on the known material condition and history of the system or equipment*;
- all identified hazards;
- an assessment of risk; and
- a means of controlling the risks.

(*The first three items are often grouped together and called the *Design Disclosure Document*.)

Safety Cases

A safety case is a comprehensive and structured set of documents that demonstrate the safety of a ship or equipment, and is summarized in a *Safety Case Report*. The safety case is initiated by operational requirements staff, prepared by the procurement authority, maintained by the design authority, and used by the operating authority. The safety case ensures a clear audit trail exists from initial conception to disposal. The mandatory elements of a safety case include:

- a Description;
- a Formal Safety Assessment ;
- a Safety Management System description; and
- Emergency and Contingency Arrangements.

The *Description* explains the nature and operation of the ship, a system or equipment. It will include the staff requirement, the procurement specification, refit specifications, or other requirements documents that describe the intended role. The amount and level of documentation will be appropriate to the current stage in the life cycle.

The *Formal Safety Assessment* (FSA) is the nucleus of the safety case, and should not be confused with the safety assessment discussed earlier. An FSA includes:

- a Hazard Analysis;
- a Risk Assessment; and
- Hazard Control Measures.

The *Hazard Analysis* identifies and quantifies the nature, likelihood and severity of potential accidents. The most severe are called *key hazards*. The *Risk Assessment* evaluates the combination of the hazard severity with the probability of occurrence and the tolerability of consequences. The Risk Assessment justifies conclusions with evidence and records all principal criteria and assumptions. *Hazard Control Measures* include methods to remove, mitigate, or control the consequences of a hazard. Control measures could include redesign, an engineering change, training, operating procedures, or other management methods. The Formal Safety Assessment pays particular attention to key hazards and emergency systems.

A safety case includes a written description of the safety management system to ensure safety aspects are covered and that authority and responsibility are clear and unambiguous. A summary of emergency and contingency arrangements is essential. These arrangements include measures to ensure adequate escape from a vessel and the preservation of life until rescue.

Key Hazard Areas											
Table 1 - Submarine Safety Document Register	Structural Strength	Stability	Watertight Integrity	Shipborne Munitions	Magazine Construc-tion	Fire protection	Escape and Rescue	Manoeuv-ring and Control	Air Purification and Monitoring	General Lifting Appliances	Misc. Documents
Certificates of Safety											
Certificates of Acceptance											
Certificates of Conformance											
Survey Reports											
Survey Documentation											
Pressure Testing											
One Man Control Survey and Defect											
Magazine Inspection											
Escape Inspection											
Lifed Item Records											
Register of Flexibles											
Register of Pressure Vessels											
Rigging Warrant											
Anchor and Cable Certificate											
Survey of Wire Ropes											
Configuration Records											
Sleeve and Socket Weld Register											
Register of Brazed Joints											
Register of Cryofit Couplings											
Ballast Statement											
Hull Circularity Checks											
Salvage Drawings and Docking Plan											
Safe to Dive Certificate											
Report of Docking											
Report of NAB Revalidation											
Register of Hull Fasteners											
Concession Lists											
A&A Completion											
Fire Protection Documentation											
Closing Up Report											
Statement on Modifications											
QA Datum Pack											
Exterior and Interior Photographs											
As-Fitted Drawings											
Updated FLADS											
Operating Constraints											
Propulsion Power Statement											
Manoeuvring Limitation Diagram											
Authorisation to Charge Batteries											

Victoria* enters Campbeltown, Scotland following her first week of sea trials. *(Photo courtesy PM SCLE)

The design authority holds the safety case. MoD is just starting to manage surface ship safety using safety cases. Discussing how the submarine design authority will proceed is somewhat hypothetical; no in-service submarines have a full safety case. The information in a submarine safety case will be much too large to manage without a structured approach. Appropriate sections in the design authority will have to control elements of the safety case, much like the current breakdown of responsibility for safety assessments. An overall co-ordination role for the safety case and, in particular, the *Safety Case Report* will be essential.

Safety Certification

JSP 430 identifies key hazards that require certification. Submarines operate in a harsh environment and key hazards represent the greatest risk of loss of life, serious injury, or damage to the environment. MoD uses Certificates of Safety during the operational phase of a vessel's life cycle to focus attention on these key hazards and to ensure that responsible authorities give key hazards due consideration.

Certification provides assurance that the material state is satisfactory and that a vessel is safe when used within the intended role and within the operating limits. Certificates provide the Secretary of State for Defence confidence that his "duty of care" to the submarine crew, the public, and the environment is fully discharged. Certificates of Safety cover the initial design, the implementation of the design at acceptance from the shipbuilder, and the operation and maintenance of the design in service.

Certification for key hazards is mandated in Chapter 4 of JSP 430. Procedures are established and implemented for some key hazard areas; for other areas the procedures are being developed or revised. Eventually, Certificates of Safety for submarines will cover the following key hazard areas:

- Submarine Structural Strength (CSSS): *procedure established, pilot implementation under way;*
- Stability: *procedure established and implemented;*
- Watertight Integrity: *procedure established and implemented;*
- Shipborne Munitions (CSSM): *procedure established and implemented;*
- Magazine Construction: *procedure established; implementation deferred;*
- Fire Protection: *procedure established; implementation deferred;*
- Escape and Rescue: *procedure and implementation deferred;*
- Manoeuvring and Control: *procedure and implementation deferred;*
- Air Purification and Monitoring: *procedure and implementation deferred;*
- General Lifting Appliances: *procedure and implementation deferred.*

The submarine design authority has a well-developed formal procedure to assess the safety of in-service submarines. Certificates of Safety have existed for over a decade in some key hazard areas. The design authority is introducing safety certificates incrementally in other areas as boats leave major refits. Certificates are end-dated, but otherwise remain current provided all prescribed maintenance is undertaken. The design authority must review certificates when the material state of the submarine is brought into question:

- after refit;
- on expiry;
- when the safety is adversely affected by
  - a major defect,
  - an accumulation of minor defects,
  - incomplete safety-critical maintenance;
- following a change in the original design intent; or
- following a change in upkeep policy.

The Submarine Safety Management System

The MoD submarine design authority has established a comprehensive safety management system for in-service boats. The system lays out requirements for safety cases, safety assessments and safety certification for submarines and equipment. Implementation of all components of the system is proceeding slowly; safety certification is not fully developed and safety cases are not fully implemented. However, the formal safety certification process that predates the requirement for Certificates of Safety continues to guarantee the material state of submarines. This process is well established and will simply expand to include future Certificates of Safety. The formal safety certification process is discussed in more detail later.

Retrospective application of JSP 430 to existing submarines presents a major challenge for the design authority. A safety case started at the beginning of a project easily forms the backbone for control and management of the design in service. Finding the design information for even a safety assessment after the fact can prove daunting. However, a defensible high-level

Safety Case Report

The Safety Case Report is an executive summary. It presents the essential elements of the Safety Case to line managers in one document. It assists Responsible Authorities to review performance and to decide whether to proceed from concept to design, from design to construction, from construction or refit to operation, or from operation to disposal. As the Safety Case Report includes items relevant to safe operation, operators will hold a copy of the Report.

assessment is required since a record of safe operation is not, in itself, an adequate justification of the material state. Certificates of Safety issued on the basis of a safety assessment will contain appropriate caveats to indicate where the audit trail for design and construction aspects is incomplete.

The MoD submarine design authority has completed a retrospective safety assessment of the *Swiftsure* and *Trafalgar* classes, and is working on a similar safety assessment for the *Vanguard* class. A mid-life refit on some *Trafalgar*-class submarines sits astride the boundary between safety assessments and a full safety case. The refit significantly alters the design intent of the boats. MoD has developed an interesting compromise to revalidate the material state with a mix of assessments for original systems and equipment, and a safety case for the design change. Had MoD decided to reactivate *Upholder*-class SSKs for RN service with an air-independent propulsion (AIP) plant, a similar compromise would have been necessary. The changes AIP brings to the *Upholder* class would require at least a limited safety case because of significant changes to the original design intent.

Submarine Safety In-Service

Safety certification for RN submarines began over 30 years ago when MoD introduced the D234 Safe to Dive Certificate. It was the first formal process to guarantee the correct material state of a submarine in service. The Safe to Dive Certificate focused on watertight integrity and was used in the handover process when a submarine left a shipyard and entered, or re-entered, operational service with the navy. The Safe to Dive Certificate was issued within 48 hours before departure after successfully completing watertight integrity checks. Once a submarine was operational, watertight integrity and safety relied on the ship's company and their internal procedures such as sea checks and work-ups.

The safety certification process for the material state is now much more comprehensive. Certification has expanded from the watertight integrity check of the Safe to Dive Certificate to a *Submarine Safety Document Register* containing over 30 certificates covering many submarine hazards. The process provides assurance that a submarine is materially fit to go to sea using work acceptance documents from build, refit or upkeep (as appropriate) together with the *Register*. MoD introduced the *Submarine Safety Document Register* as a contractual requirement when navy yards were privatized. Successful completion of work and a satisfactory material state yields a "Safe to Dive" period for the operating authority (typically for a commission of eight to 10 years, depending on the class).

Safe to Dive

Safe to Dive is that property of a submarine, confirmed by the safety management system, representing a safe material state for operations. Maintaining Safe to Dive status relies on proper maintenance and operation in accordance with the design intent.

Work Acceptance

Control of work is important to ensure submarines continue to meet the design intent and can operate within design limits. Review of the work at the completion of refit can take two to three days to consider whether:

• the contract has been satisfactorily completed and the design intent has been maintained (repair authority review);

• all work on the material of the submarine has been completed by ship's staff, base staff or other contracted organizations, and the design intent is maintained (ship/base staff review);

• the ship's company is properly prepared to proceed to sea and no defects that affect the safety of the submarine exist (FOSM/squadron review); and

• significant omissions exist that affect safety and whether the submarine is in a safe material state to proceed to sea (design authority review).

The review culminates in three meetings: the Contract Acceptance Meeting, the Fleet Date Inspection Meeting, and the Sea Clearance Assessment Meeting. The Contract Acceptance Meeting considers reports of work outstanding from the refit contract, concessions, and objective evidence on the material state of the vessel. This meeting only confirms that the work requested was completed satisfactorily; it cannot confirm that the work requested is sufficient to restore the material state of the vessel to the design intent. The meeting results in the Contract Acceptance Certificate signed by the repair contractor, the commanding officer, and a representative of the MoD repair authority.

The Fleet Date Inspection examines the readiness of the submarine crew for sea, the stores held, the documentation on board to support the operational period, the status of the ship's maintenance, and any operational deficiencies not included in the refit. On successful completion of this inspection, the commanding officer and the squadron or FOSM representative sign a Fleet Date Inspection Meeting Report Certificate.

The Sea Clearance Assessment Meeting is chaired by the design authority and reviews the refit acceptance document (Form D237a), and the results of the Contract Acceptance Meeting and Fleet Date Inspection to consider whether the submarine is safe to proceed to sea. The meeting also considers any caveats and the interaction of caveats from the other two meetings. At the Sea Clearance Assessment Meeting,

Definitions

Duty of Care — the responsibility of an employer to ensure, as far as it is reasonably practicable, that the health and safety of the crew, the public and the environment are not affected by the employer's acts or omissions.

Design Authority — the line management organization in MoD with responsibility and authority to ensure that the material state of a submarine complies with the design intent.

JSP 430 — An MoD joint services publication outlining the departmental policy and high-level requirements for ship safety management.

Key Hazard — major hazards to the material state of a vessel that represent the greatest risk of loss of life, serious injury, or damage to the environment and may result in a total loss of the vessel.

Material State — status of a ship, component systems and subsystems, and equipment. Material state affects the operational ability of a ship to perform duties anticipated in the design intent.

Responsible Authority — the line manager with responsibility and control of safety management for a ship, system, or equipment during a phase of the life cycle.

SSMS — The Ship Safety Management System describes the overall structure to implement MoD's safety policy framework.

A **Safety Management System** is a component of the safety case and describes how a responsible authority will implement MoD's Ship Safety Management System.

the design authority confirms that the material state of the submarine still meets the design intent. The meeting concludes with a "SCAM Certificate" signed by the ship, the operating authority, the repair contractor, the design authority, and a representative of the MoD repair authority.

These meetings and the three resulting certificates constitute an assessment of the safety of the submarine and the adequacy of the crew. Following these meetings, and prior to post-refit sea trials, crew preparedness is confirmed alongside by Captain Submarine Sea Training.

Base upkeep work is controlled locally by ship's staff. The design authority is concerned with verifying that all tasks stipulated for the base upkeep have been completed in accordance with the relevant specifications and standards. The satisfactory completion of work is indicated to the design authority using the *Control Document* and supporting documentation.

The Submarine Safety Document Register

The *Register* contains Certificates of Conformance, Certificates of Acceptance, and Certificates of Safety organized by key hazard areas in a certificate hierarchy; lower-level documents support the issue of higher-level documents. *Table 1* illustrates the contents of the *Register* as a matrix of the components organized by key hazard area. Unfortunately, documents in the *Register* are sometimes collectively referred to as "safety certificates." The term does not distinguish the importance of individual documents and can be misleading.

Certificates of Conformance for survey reports, lifed item records, configuration records, and operating constraints are low-level documents. Certificates of Conformance accompany each item of supporting documentation required by the design authority to clear a key hazard. A competent engineer nominated by the MoD repair authority signs them. Where the ship provides documentation, a responsible ship's officer signs certificates. In some cases the Certificate of Conformance is the document (the D234 Safe to Dive Certificate being a prime example).

The design authority relies on Certificates of Conformance as important evidence in signing Certificates of Acceptance, which are intermediate-level documents. Design authority section heads sign Certificates of Acceptance on proof of supporting documentation indicating safety clearance of components of a key hazard. The collection of acceptance certificates constitutes the proof the responsible design authority needs to sign Certificates of Safety.

Certificates of Safety are top-level documents and demonstrate clearance of a key hazard. In key hazard areas when no safety certificates exist, the design authority uses the collection of acceptance certificates instead. Once all key hazards are cleared, the responsible authority for design signs the *Submarine Safety Document Register* to guarantee a safe material state for the operating authority.

The Future of Submarine Safety Management

Submarine safety management is under continuous assessment. *Astute*, MoD's newest submarine project, is providing an excellent opportunity for an introspective review of submarine safety management. The *Astute* prime contractor is required to use a safety case to underpin the development of the submarine design. *Astute* will be the first opportunity for MoD to manage a full safety case for a submarine, and will provide a comprehensive first-principles check of major submarine hazards. Already the *Astute* project has challenged key assumptions on certification required by the *MoD Ship Safety Management Handbook* (JSP 430) and will continue to push MoD and the RN to review established policies.

Work Acceptance Documents

Form D237a — *Refit acceptance*

Control Document — *Base upkeep acceptance*

Contract Acceptance Certificate — *Refit work confirmation*

FDI Meeting Report Certificate — *Maintenance and OPDEF confirmation*

SCAM Certificate — *Material state meets design intent*

The key hazards *and* certification requirements for *Astute* will be an output of the Formal Safety Assessment. For in-service boats JSP 430 predefines key hazards, which are then used in safety assessments to group subordinate hazards for consideration. Predefining the hazards for a Formal Safety Assessment compromises the integrity of a safety case.

The result of the *Astute* safety case may be new or different key hazard areas. Most key hazards identified in the *Astute* Formal Safety Assessment will be common to all in-service submarines. With *Astute*, MoD will be able to revise, and perhaps confirm that existing procedures mitigate all the major hazards faced by submarines. The Formal Safety Assessment will dictate the most appropriate control measures (that may not even include Certificates of Safety).

The safety management process has developed in response to known and anticipated hazards. MoD policy will ensure that the Submarine Safety Management System will develop to respond to the information gained from *Astute*'s safety case.

Conclusion

The MoD has a world-class Ship Safety Management System. The Ministry has not only established the policy and high-level requirements, but the Ship Safety Board, through the Ship Safety Management Office, has worked hard to foster a safety culture. Safety management cannot be successful unless the whole organization is committed. Design authorities have responded with safety management systems to develop new designs and to manage in-service assets. Operating authorities have incorporated safety management principles during operation.

Unfortunately, this summary covers only the highlights of MoD safety management for submarines. Many important issues on the Submarine Safety Management System were not discussed; such as, the critical role of safety audit and feedback, the resources required by the design and operating authorities to manage safety, and the standards and guidance documents prepared and maintained by specialist authorities.

The Submarine Safety Management System is just one small component of the Ship Safety Management System, but it illustrates the commitment and resources that U.K. MoD is willing to apply to ensure that the material state of HM submarines is satisfactory. MoD provides an excellent benchmark for DND as we begin to develop the structure to support the new *Victoria*-class SSKs.

LCdr Peer is on exchange with the Royal Navy, working in the Submarine Naval Architecture section of the Defence Procurement Agency.

Technical Evaluation:

Data Collection — System Analysis Simulation Evaluation System

Article by Lt(N) Drew C. Smeaton

As project manager of the RIM 7P missile upgrade project I had the opportunity to work on an interesting technical evaluation of the System Analysis Simulation Evaluation (SASIE) system from Thomson-CSF Elektronik of Germany. The purpose of the techval was to purchase, customize and install a data collection and analysis system in a *Halifax*-class ship for a missile firing in Puerto Rico. The project was a success, and I would like to provide information about the SASIE system and my experience with it as it may have application in other areas of the Canadian Forces.

In the early 1990s the navy actually initiated two projects to deliver a comprehensive combat system data collection and analysis capability. The first was PMAS (*see "A CPF Combat System Performance Monitoring and Analysis System," Maritime Engineering Journal, February 1994, page 10*), which was designed as a prototype and never went into production. The second was the Performance Evaluation System, which never made it past the technical statement of requirements stage. Delays with PES eventually led to its cancellation in favour of SASIE.

SASIE is a versatile data collection, analysis and simulation system that was developed by Thomson-CSF for the German navy. It was originally conceived to correct problems associated with missile firings in the F-122 frigates in the early 1990s. It has since evolved into a whole-ship system capable of collecting data from all onboard sensors, weapons, combat management systems and consoles. SASIE can tap into any predefined interface on board ship (i.e. all standards of the Naval Tactical Data System, video, audio, synchro/resolver, ACPARP, SCSI, Ethernet, FDDI, ATM, Link 11/16 and IRIG-B), and has the capability to generate realistic combat training scenarios using a ship's command and control system, ESM/ECM systems, navigation data controller and radar systems.

The German navy presently uses SASIE for software verification and validation of changes to its combat management systems, and to validate new equipment trials for radar and weapon systems. The system is also capable of providing multiplatform data fusion from several exercise units, and was even used for *international* data fusion between German and

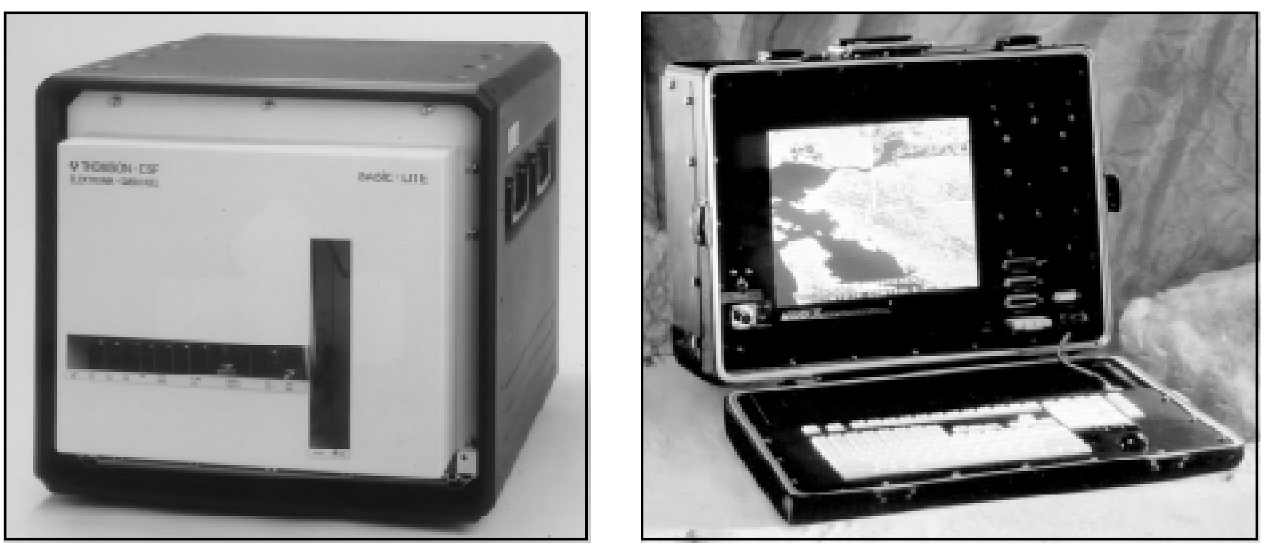


Fig. 1. A System Analysis Simulation Evaluation system purchased for technical evaluation from Thomson-CSF performed well during a *Halifax*-class missile shoot off Puerto Rico last year. The SASIE "Lite" system's data logging computer (left) and portable workstation were installed in the frigate HMCS *Charlottetown* to collect and analyze missile firing data during Exercise El Morro Castle.

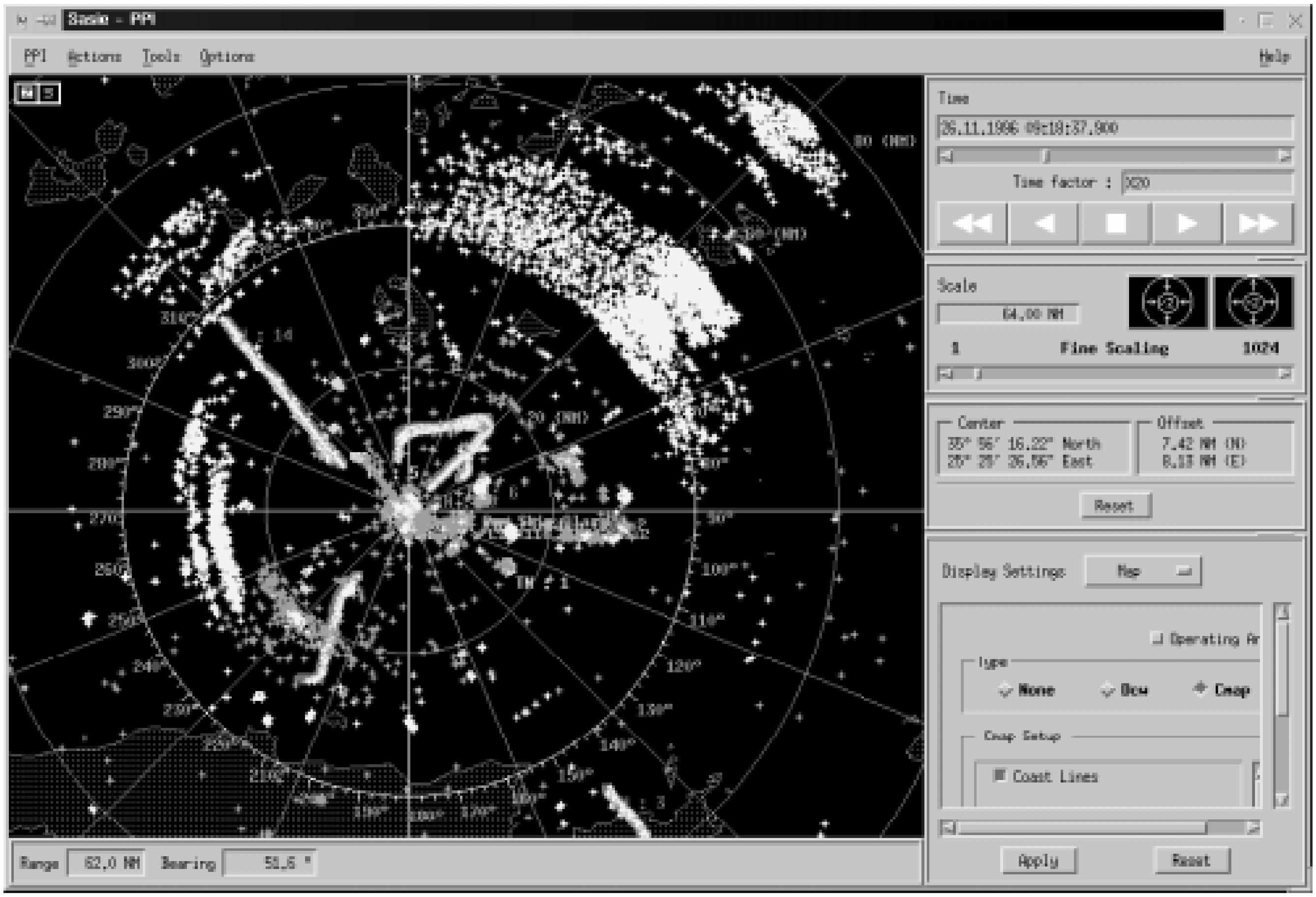


Fig. 2. SASIE allowed personnel on board *Charlottetown* to observe a real-time plan position indicator (PPI) display of the missile-firing data being gathered by the ship's command and control system during the shoot.

Canadian ships during the Puerto Rico missile firings.

The SASIE system can be purchased either as a permanent installation, or as a portable system, but both require permanent cabling to be installed on board ship. The permanent installation requires a 19-inch rack installation and a permanently fitted display. The Canadian navy presently owns two portable SASIE "Lite" versions, which can be installed in a few hours by connecting a data logging computer and portable workstation (*Fig. 1*) to permanently installed cable systems. Both computers use a VME bus structure and have a 9.4 GB hard drive. The portable workstation has a CD-ROM and digital audio tape drive for loading and exporting data. The operating system is AIX UNIX.

The first SASIE system was accepted in March 1999 and installed on board the frigate HMCS *Charlottetown* to collect data from Exercise El Morro Castle missile firings off Puerto Rico. (SASIE was later installed in the *Iroquois*-class ships *Algonquin* and *Athabaskan* for Year 2000 testing and missile shoots.) In *Charlottetown*, meanwhile, the system was set up primarily for an above water warfare application, with interfaces to the ship's command and control system, radar, fire-control, inertial navigation and global positioning systems, as well as to the missile launch controller. The portable workstation and data logging computer were connected by Ethernet, while all interfaces from ship systems were connected to the data logging computer via their own special cable taps patented by Thomson.

For each interface, Thomson wrote an interface program in C based on the equipment's interface description document. The messages from each interface were properly recorded with respect to message length and data words, and each message was time stamped with an IRIG-B timing signal synchronized with the GPS interface. The result was that the raw data was always available in its unaltered form for analysis. The raw data was saved to disk and could be viewed on-line in real time. SASIE uses a message description language (MDL) to look at the raw data stream and interpret the words into the messages as defined by the interface description document for that equipment. Personnel at the Naval Engineering Test Establishment (NETE) are trained in, and have been tasked with writing most of the software for the MDL code. *Figure 2* shows the data displayed in plan position indicator (PPI) mode. Listings of the messages can be displayed in raw octal format, message format or detailed message format to allow for analysis at the bit level, message level, or system level.

The analysis capabilities of SASIE are extensive. At the system level, SASIE allows the user to observe the ship's command and control system (CCS) gathering data and displaying it in PPI format, in real time, or via the playback mode. Information not normally seen on the CCS can also be displayed. For example, the different tracks generated by the various radars for a single target can be displayed and analyzed simultaneously. The predicted points of intercept for missile firings can also be seen. The plots seen by a radar and the tracks generated by that radar (and the difference between the two) can be displayed simultaneously and checked for correlation.

At the message level, the interfaces between equipment and the CCS can be checked for accuracy, or to see if software changes have inadvertently affected message transfers for a particular interface. Any change in a validated system will result in SASIE showing new messages as "UNKNOWN." (This phenomenon was already observed once at the Combat Systems Training Centre in Halifax when the CCS software changed from version 4.1 to 4.2.) At the detailed message level SASIE can manipulate data through graphs (four variable Cartesian graphs, or histograms), or through mathematical analysis. The math functions allow the user to manipulate sensor message data and produce new fields which can then be graphed. At the bit level, SASIE can display in binary or hex format all data flowing between equipment at the physical interfaces.

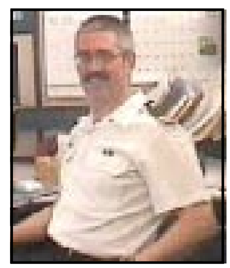
A significant benefit of the SASIE system is its adaptability. If you can describe the interface protocol and messages you want monitored through an interface description document, Thomson can customize a hardware and software interface to capture the data on it. Even existing data collection systems can be incorporated into SASIE. For example *Charlottetown*'s system tapped the missile launch controller (MLC) data extraction port to collect MLC data during the launch. A potential further development might be to design a SASIE replacement for the MLC notebook currently used to control the MLC data extraction port. This would eliminate the need to manually activate MLC data recording, and would allow the data to be viewed along with all other SASIE-collected data, rather than having to collate it by hand, or transport it to another analysis system for viewing alongside other data. SASIE is presently collecting data on German and Canadian ships, the German Tornado fighter aircraft, and German and French air traffic control systems. All data in SASIE is referenced to the single GPS time stamp.

Do we need a system like SASIE? Well, three important benefits can be realized: The first is the delivery of timely feedback to the operators. Our present Combat System Audio Visual Recording and Analysis System (CSAVRAS) allows a quick look at operator actions during a missile firing, but not at the technical side of things. The data must be collected, and in some cases ported to other programs and media for analysis. SASIE provides that all-important immediate quick-look at the technical aspects of a missile firing.

The second benefit is the reduction in the number of data collection systems that are needed on board ship. For example, as we demonstrated during our missile firing event, a single system was able to gather data from the STIR fire-control data logger, the missile launch controller, the CCS history recorder and the interface itself. It could even be expanded to meet additional data collection requirements in other areas such as electronic warfare and anti-submarine warfare.

And finally, a reduction can be realized in the time spent gathering, downloading and translating data to other programs. This will allow more time for data analysis and feedback to the fleet.

As a result of the SASIE trials in *Algonquin* and *Athabaskan*, the Directorate of Maritime Project and Policy Development, on the advice of the Maritime Automated Data Collection and Analysis Committee and the Canadian Forces Maritime Warfare Centre, has selected SASIE to replace the Interface Monitoring System in the IRO class. A project has been initiated to fit the remaining IRO-class ships and the TRUMP Software Support Centre with cables for a SASIE Lite system, and to purchase another SASIE Lite system. The Directorate of Maritime Ship Support continues to review the navy's data collection and analysis requirements.



Lt(N) Smeaton is a project engineer in the Above Water Warfare (Sensors and Weapons) section of the Directorate of Maritime Ship Support in Ottawa.

HMCS *St. John's* Maintenance Capability Study

At this year's East Coast Naval Support Seminar in Halifax at the end of May, Combat Systems Engineering Officer **LCdr Lou Carosielli** and Marine Systems Engineering Officer **LCdr Joel Parent** reported results from their own eight-month pilot study of maintenance capability on board HMCS *St. John's* (FFH-340). Backed by hard data, their study validated what many people in the technical support community already knew to be true — that our technicians don't have enough time for maintenance, and that the time they do have is being spent primarily on corrective maintenance. Here is their abridged report:

The aim of the HMCS *St. John's* Maintenance Capability Study was fourfold:

- To better define the high-maintenance workload of *Halifax*-class ships, which is a continuous challenge that has not been met and has resulted in a significant amount of outstanding maintenance;
- To validate and put discrete values to what the engineering community as a whole already knows, but cannot discuss in a quantitative manner;
- To provide a means of easily collecting the required data from all technicians, thereby increasing the probability of collecting more accurate data; and
- To provide supervisors and command with the required information to make better decisions with respect to personnel employment and maintenance priorities.

We began by liaising with senior technicians so that we could develop a model that would predict the number of hours that technicians of both engineering departments (i.e. combat and marine systems) spend on a monthly basis conducting various activities. This model was based on experience, and its basic assumptions were for a ship alongside at normal readiness with 6.5 working hours a day. *The model predicted that our technicians would spend, on average, only 25 percent of their time on maintenance activities.* The remaining 75 percent of their time, the model predicted, would be spent on non-maintenance tasks such as departmental administration, leave, training, etc.

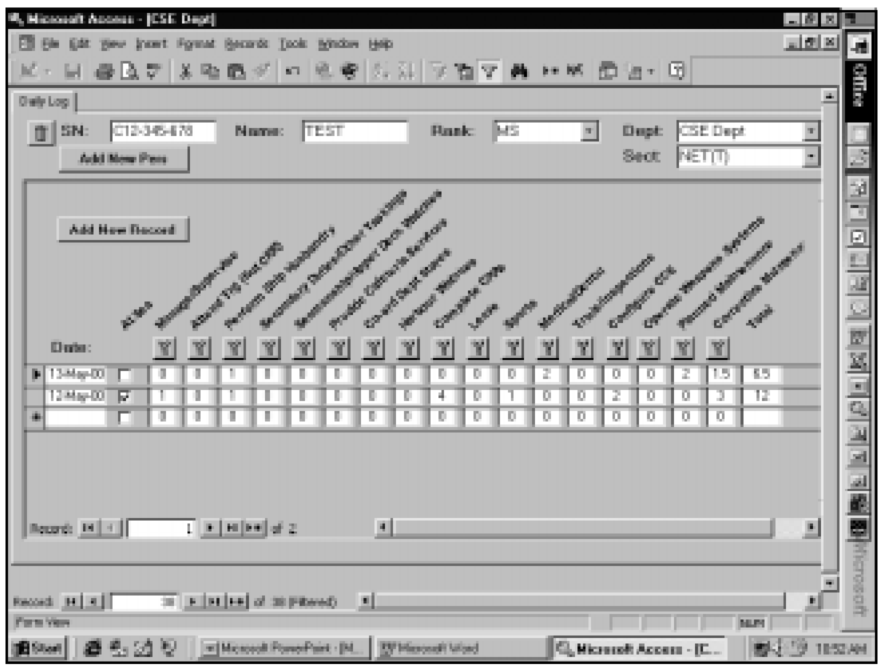


Fig. 1. Technicians on board HMCS *St. John's* used this computerized time sheet to record personal daily activity. The data was then collated and used to validate an onboard maintenance capability study.

Once all supervisors were comfortable with the model, detailed briefs were provided to all technicians to ensure that no major items were overlooked and to discuss the best means of collecting the data required to validate the model. These discussions proved to be exceptionally effective as junior technicians were able to provide and implement sound suggestions, thereby enabling them to take ownership of the data collection portion of the study.

After several iterations, a user-friendly Microsoft Access timesheet (*Fig. 1*) was developed which automated the data collection/collation process. Technicians were able to enter their daily activity data in a minimum of time, using PCs in their personal work spaces, and each

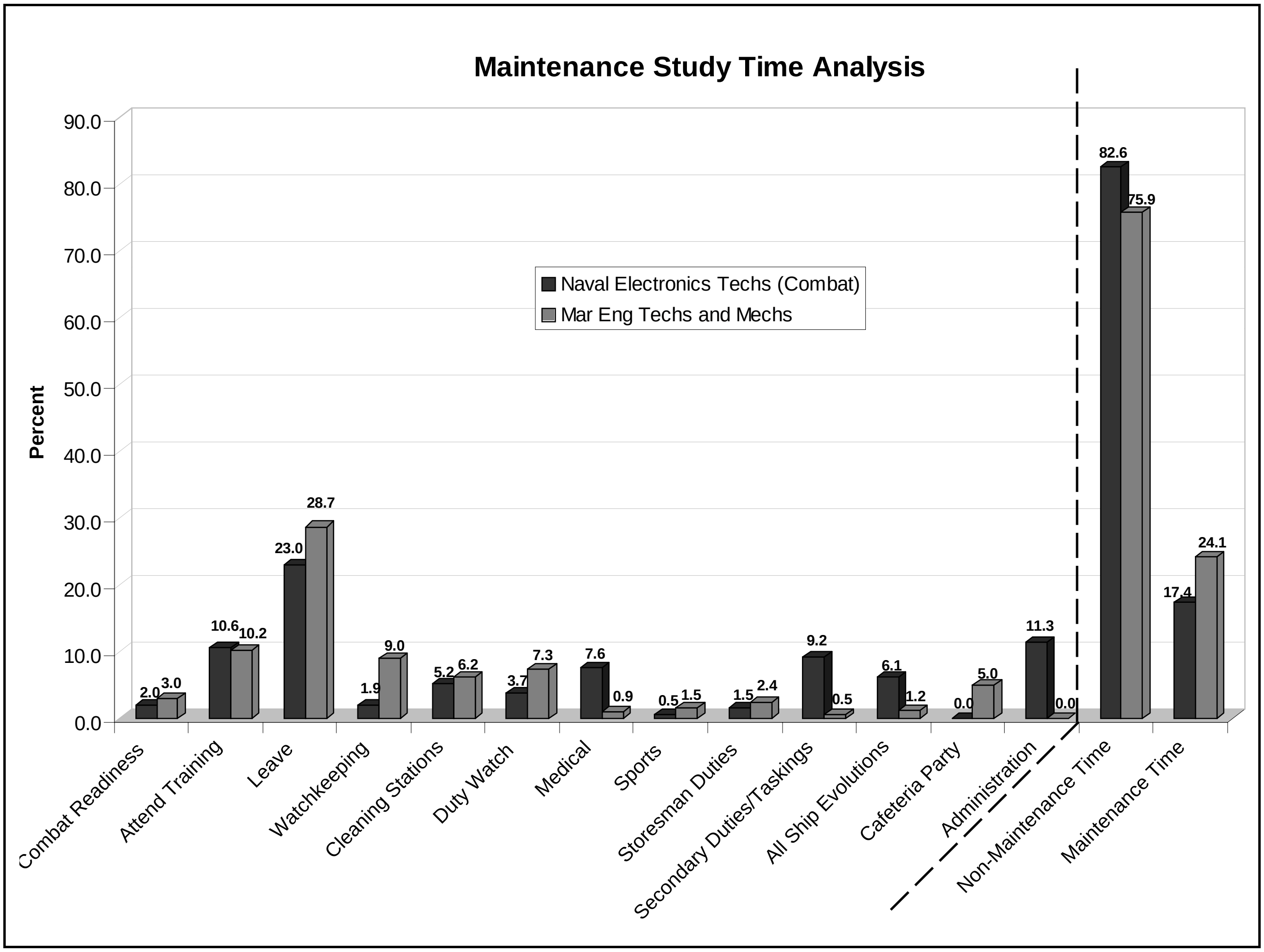


Fig. 2. Actual data from the HMCS *St. John's* Maintenance Capability Study validated a study model which predicted that technicians spend about 75 percent of their time on non-maintenance activities.

month the program would automatically collate the data and produce activity graphs that could be easily analyzed to assist in making departmental and shipwide decisions.

As seen from the sample CSE department timesheet shown in *Fig. 1*, a technician would enter the amount of time he or she spends during a particular day doing one or more of the 16 activities shown on the form, and indicate if the entry was for a day alongside or at sea. This process simplified data collection, produced valid analytical data, and enabled more detailed analysis as required. The MSE department used the same timesheet with a similar set of activities.

Maintenance Study Time Analysis

The results were much as predicted. A quick glance at the maintenance time analyses for certain sections of the CSE and MSE departments (*Fig.2*) illustrates just how closely the data agreed with the model. The general similarity of the activity profiles between the two departments is also obvious. The study showed that, from September 1999 to April 2000, the Marine Engineering Technicians and Mechanics spent an average of just 24.1 percent of their time progressing maintenance that included both planned and corrective maintenance. The remaining 75.9 percent of their effort was all non-maintenance activity. By comparison, the Naval Electronics Technicians (Combat) spent only 17.4 percent of their effort on maintenance, and 82.6% on non-maintenance activity. (The accuracy of these results was determined to be about 80 percent.)

Of the *non-maintenance* activities, leave was by far the largest component reported by both the NET(C)s and Mar Eng occupations (23% and 29%, respectively). This was driven by a requirement for personnel to use up all 25 days of their annual, Christmas, and other leave. Similarly, percentages for attending refresher training and other MOC specific training were also high for both groups, at just over 10 percent, due to a push last fall to have personnel complete refresher training in time to free the maximum number of technicians for an upcoming directed work period. There were some differences, of course, relating to the different employment of the various occupations, and depending on whether the ship was alongside or at sea, but generally the overall activity profiles were a fairly close match

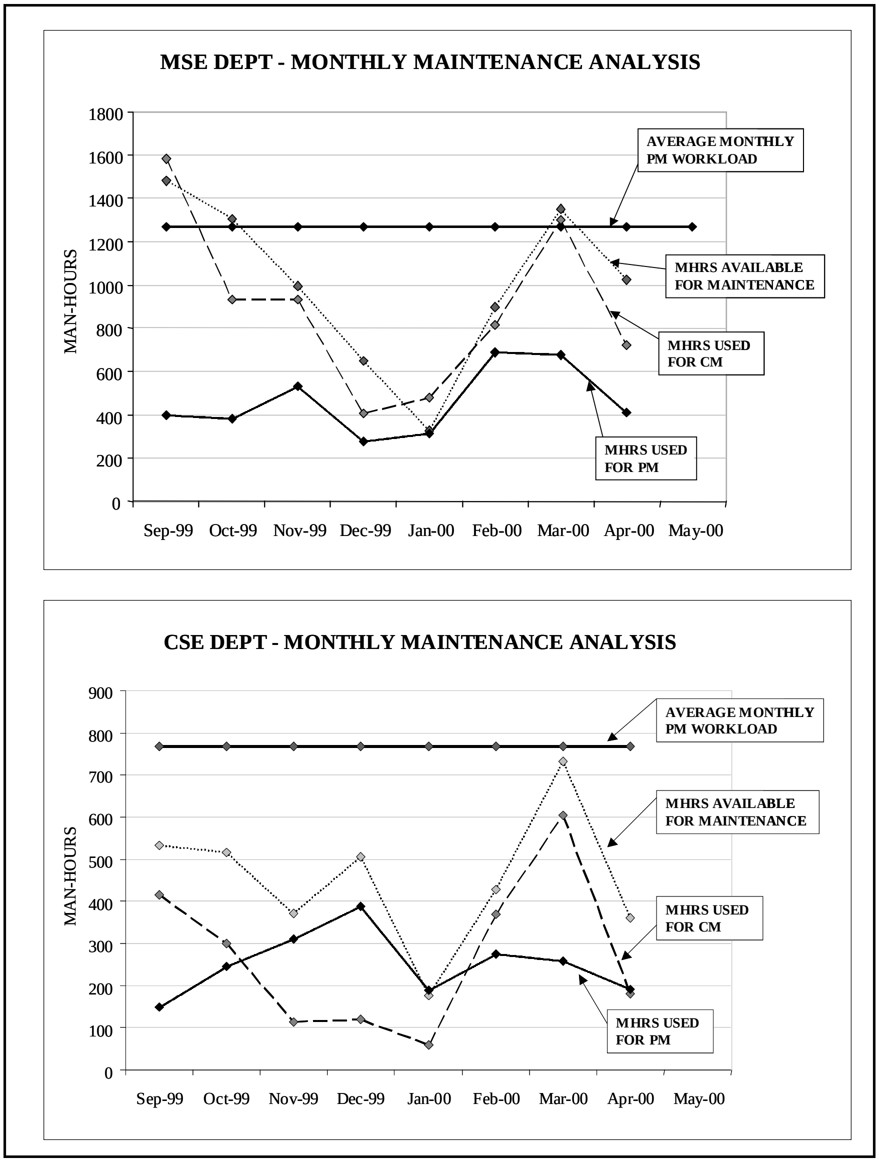


Fig. 3. The overall monthly maintenance man-hour expenditures show what most people in the technical community already know — that we spend a lot more time fixing equipment than we do trying to prevent failures in the first place.

with each other and with the model prediction.

Monthly Maintenance Analysis

Is an average of 25 percent or less of technicians' time sufficient time to accomplish all of a department's planned and corrective maintenance? The graphs are quite revealing in this respect.

Figure 3 shows the month-by-month overall maintenance man-hour expenditures for the MSE and CSE departments. The average monthly planned maintenance (PM) workload — the straight horizontal line — remains approximately constant from month to month. This figure is derived from PM schedules and load charts, and is the total amount of time that should be spent every month on planned maintenance to accomplish the whole ship's staff PM workload. For the MSE department, it is 1250 man-hours.

The line indicating the man-hours available for maintenance represents planned and corrective maintenance (CM) combined. In other words, it is the time available to progress maintenance once all the time spent on other activities has been subtracted from the total available time. The large drop during the December-January time frame was due to more time being spent on leave and Operation Abacus Y2K training. The line then climbs back up in February and March when the ship was in a directed maintenance period.

The line showing actual hours spent on CM closely follows the available hours line, particularly in the case of the MSEs. This means that most of the available hours for maintenance were being consumed by *corrective* maintenance. We spend a lot more time fixing equipment than we do trying to prevent failures in the first place.

Now look at the last line on the graphs — the total hours spent on planned maintenance. It is well below our PM workload line indicated by the straight horizontal line. In some months we spent only a third of the time that we should have been spending on PM. In other months, it was a little better at one-half, but in general we do not have enough time to meet the PM workload. While this means that we will certainly begin to accumulate outstanding PM routines, it does not necessarily mean that the number of outstanding routines will, for example, double each month in which we only manage to complete half the required hours. In many cases planned maintenance routines "roll up" (i.e. a monthly routine becomes part of a three-month routine; a 3M part of a 6M, and so on), but in any event we prioritize our effort to ensure we don't leave any system or equipment unmaintained for any great length of time.

The potential impact of carrying a planned maintenance overhead is mixed. While not all PM routines necessarily increase the reliability of a particular system, incomplete PM in general could lead to higher failure rates or diminished performance. Reliability may be an inherent design characteristic of our equipment today, but if equipment begins to fail more often we will end up with a greater workload of corrective maintenance, leaving us even less time to progress planned maintenance...and a vicious circle continues.

Addressing the Problem

How should we address this problem?

• We are already focusing on the maintenance actions that keep the ship seaworthy and mission-ready, so our critical corrective maintenance is under control. But we should also continuously review the planned maintenance requirements. As we gain more in-house expertise on systems and equipment, we should be in a better position to eliminate PM that does not really increase mission or technical readiness. We should perhaps be looking for more efficient EHM techniques, and introduce more reliability centred maintenance that calls for "just-in-time" planned maintenance, done at the most optimum time, to prevent failures.

• REMAR (manning) positions are obviously governed by bunk space, but having more technicians on board ship would definitely help alleviate the maintenance problem. One U.S. Navy supply ship is conducting an interesting experiment in which a crew of civilian utility workers is being employed to perform various communal tasks. The aim is to minimize the out-of-trade work normally performed by the sailors, giving them more time to concentrate on the primary job skills they were trained for. It will be interesting to see the results of this.

• In our own case, the engineering departments on board HMCS *St. John's* usually do not participate in communal tasks such as storing ship, and cleaning stations have been reduced to three times a week when the ship is alongside. These are just examples of some activities that can be reduced to free up more time for maintenance.

• Training, regardless of whether it is conducted on board ship or ashore, takes up a lot of time — on average, more than 15 percent of our total activity time. Some sections spend as much time on training as they do on maintenance. Have we really established an optimum threshold between training and maintenance? Some training is within the ship's control, some of it is not. We need to address this issue as an organization.

• Some first-line planned maintenance could be completed by the fleet maintenance facilities if they have the capacity to do so. If the ship raises a Maintenance Action Form, the repair facility could complete it during times when most of the fleet is away and the repair workshops are not so busy, as was demonstrated during our last directed maintenance period.

• Finally, ships should provide support to initiatives such as the long-term maintenance review and the in-service reliability study. In the long run, these should optimize our maintenance efforts.

In conclusion, our maintenance problem stems from the fact that our technicians do not have enough time for maintenance, and that the time that they do have is being spent primarily on corrective maintenance. Our study continues. With the shipwide, activity-based costing initiative we now have on board *St. John's*, supervisors, managers and leaders at every level should have a good idea of how their human resources are being utilized so that they can make the most cost-effective decisions. What we have illustrated here is one way of doing it.

LCdr Carosielli and LCdr Parent were the Combat Systems and Marine Systems Engineering Officers on board HMCS St. John's. *LCdr Carosielli is currently doing post-graduate studies at RMC Kingston; LCdr Parent is now XO at FMF* Cape Scott.

Percentage of Maintenance Hours for all MOCs Tracked

CSE Department:		MSE Department:	
Naval Electronic Techs (Combat)	**17.4%**	Mar Eng Techs and Mechs	**24.1%**
NET(Acoustic)	**13.9%**	Hull Techs	**21%**
NET(Torpedo)	**14.3%**	Electrical Techs	**17.5%**
Naval Weapons Techs	**12.9%**	Firefighters	**12%**

Greenspace: Maritime Environmental Protection

A Green Ship Standard for North America

Article by LCdr Mark Tinney

The Canadian Coast Guard (CCG) hosted a two-day international workshop in Dartmouth, NS in December 1999 to explore the feasibility of developing a "Green Ship" standard for North American vessels. Ideally, such a standard would serve as a target for good environmental performance in shipping, and would include some sort of reward program with tangible benefits to ship owners and operators.

Given that such a program would have an impact on organizations throughout North America that operate vessels, the workshop was of great interest to ship operators and stakeholders. The meeting drew representation from the Canadian navy, the Canadian Coast Guard, the U.S. Navy and U.S. Coast Guard, the American Bureau of Shipping, Lloyds, commercial shipping companies, BC Ferries, Transport Canada, Environment Canada, the Department of Fisheries and Oceans, the Bureau of Green Award, and private industry.

The idea of a Green Ship standard is to set out a number of clearly identifiable and realisable goals for ship operators to achieve in terms of environmental performance, and conceivably to develop a graduated reward system that would offer the highest rewards to vessels with the highest performance. The performance factors would be chosen on the basis of technical, environmental, and economic criteria.

During the two days of the workshop, the participants attempted to agree on the elements of a Green Ship standard and the issue of rewards. They examined what constitutes good environmental performance, and what would it take to achieve that status, and tackled the difficult questions of how such a program should be implemented and administered.

The Netherlands and Norway have championed similar initiatives in their regions. The Netherlands has a Green Ship Award program that sets identifiable goals for ships to achieve. Ships that meet their goals are rewarded with reduced port service costs based on degree of performance. In the port of Rotterdam, for example, a reduction in port service fees by as much as six percent can be achieved by vessels that gain the highest rating. The port of Hamburg, Germany is pursuing a similar initiative, and the European Union is considering adopting a wide-sweeping program for all European ports.

Some shipping companies are already committed to operating their vessels in an environmentally responsible manner. In some cases, fleet operators are actually exceeding regulated requirements by following good environmental practices. Doing so is often an indicator of good business performance. Some organizations (our navy included) either have, or are in the process of having the environmental aspects of their operations certified to international standards such as ISO 14001 or the International Safety Management (ISM) Code. It should be noted that the ISM Code already provides a baseline for a number of the aspects of a Green Ship standard.

Given the limited amount of time available to the workshop participants and the huge scope of the undertaking, it was only possible to sketch out the elements of a Green Ship standard in very broad terms. However, it was agreed that the next essential step in the process is to seek support for the initiative from the various stakeholders in government agencies, regulatory bodies and private industry. Once general support has been obtained, the next step will be to define the scope and elements of the concept in greater detail.

To be successful, the process of developing a Green Ship standard will require the support and participation of all potentially affected parties, supported by an awareness and incentives program. From this it is believed that sustainable environmental benefits can be achieved. Equally noteworthy are the political, economical, educational and international benefits that could occur.

Acknowledgement

Some of the information contained in this article was extracted from material prepared for the Green Ship Workshop by Jack Cole, Director of Environmental Services, Canadian Coast Guard, Fisheries and Oceans Canada. His contribution is gratefully acknowledged.

LCdr Tinney is the former project manager for the navy's Maritime Environmental Protection Project.

Book Review

Corvettes of the Royal Canadian Navy, 1939-1945

By Ken Macpherson and Marc Milner, Vanwell Publishing Ltd., St. Catharines, Ont., 2000. ISBN 1-55125-052-7 PB. Soft cover, 176 pages, illustrated, black & white photos, plans, appendices and index. $32.95, plus taxes and shipping. Tel. 1-800-661-6136, E-mail: sales@vanwell.com

Reviewed by Harvey Johnson

It was the spring of 1939 and tensions with Germany were high. War was inevitable. Canada's naval fleet was minimal and it was paramount that new vessels be built quickly and in large enough numbers to guard the convoys that soon would be needed to ferry materiel and troops to wage war on the European continent. This is the story of the corvette, told in great detail with a style that will capture the reader. The text is supported by a rich collection of photographs, charts and drawings gathered from various sources.

Authors Ken Macpherson and Marc Milner are well known to Canadian naval history buffs as they have individually written books in this field. The present book, a new soft cover release of the original hardback edition published in 1993 (now out of print), introduces the reader to the origins of Canada's corvettes and describes the requirements for this type of vessel. The ideas that formulated the design of the ship are well covered, and no punches are pulled in describing their shortcomings, such as their legendary tendency to ride like a "bucking bronco" in heavy seas and "roll on wet grass."

HMCS Arrowhead in wartime camouflage *(CF photo NP 1009)*

On the plus side, the authors note, some sailors actually preferred the corvettes because the smaller crew size allowed a camaraderie that didn't exist in the larger ships. The descriptions of life at sea on board a corvette in the North Atlantic certainly put the reader there. Convoy and battle scenarios are included and are well detailed. The authors cover the difficulties of the inexperienced early corvette crews, most of whom had never been to sea. Even some captains had only a rudimentary knowledge of navigation in those early days of the war. "There are few instances of men and ships going to war so ill prepared," the authors write.

The description of the limited capabilities of the early weapons and sonar make it clear why it was far more reliable and effective to ram a submarine on the surface, in spite of the considerable damage it caused to the ship, than to try to kill it with a vintage 1915 breech-loading gun from a pitching and rolling deck. "Anything beyond point blank range was almost useless, and corvette captains preferred to bludgeon the enemy to death." Even still, the early corvettes were apparently little threat to a skilled submarine commander.

The authors also describe the modernization of the first corvettes, including major changes to the hull to improve seakeeping, as well as changes to accommodation and command arrangements, and the installation of ahead-throwing hedgehog ASW mortars, 20-mm Oerlikons and a quick-firing gun. They continue with detailed descriptions of the last ships built and discuss the final corvette war operations between 1943 and 1945. The major text portion of the book ends, appropriately enough, with the story of the fate of the corvettes after the war in

Book Review

a chapter entitled, “Where Have All the Flowers Gone?”

The second half of the book covers the ship-by-ship, year-by-year building and acquisition history of the corvettes that entered Canadian service. The authors have illustrated this section with 123 individual ship photographs. The appendices contain pennant numbers, operational status charts, and general arrangement drawings.

The nearly 200 beautifully reproduced photographs in “*Corvettes of the Royal Canadian Navy, 1939-1945*” are, by themselves, worth the price of the book. Many of them will likely be new to most readers who will no doubt delight in the intimate portrait this collection of photographs paints of the venerable corvette. The text is very well written, and the wealth of information it contains is obviously a result of much effort in research. This book is recommended for anyone even remotely interested in Canadian naval history and a must for the ship enthusiast.

Harvey Johnson is a DMSS 2 life-cycle manager for ships’ hull and domestic equipment.

Letters (Cont’d)

Lest we “Frigate”

One correction to the Frigate article (*“Looking Back: River/Prestonian Class Frigates — Backbone of Canada’s Post-war Fleet,” Maritime Engineering Journal, Spring 2000, page 7*): On the *Prestonian* conversion, the frigates were fitted with a twin Bofor, not a quad. The only quad Bofor I ever saw was fitted in HMCS *Ontario*. It made quite a sight when fired at a surface target. **— Pat Barnhouse, DSTM 3, Ottawa.**

(He is quite correct. I had my quads and twins mixed. I even have it on my copy of the drawing! — Harvey Johnson, DMSS 2, Ottawa.)

I read your article on the Frigates (the real ones) and enjoyed every moment of it. I was reliving old memories while having my “first of the day” coffee. Bravo Zulu. **— Bob Passmore, Ottawa.**

I…read your article in the *Maritime Engineering Journal* on the Frigates. Pretty interesting piece. I came in too late to...experience them. The closest to them that I saw was...*Jonquiere* still tied up in Esquimalt before...salvage. Thanks for an interesting piece of history. **— CPO1 Andre Robin, Trials Chief, Canadian Fleet Pacific Headquarters, Esquimalt.**

Journal Editing Award

I just read that your editorial “prowess” was recognized by the Society for Technical Communication. Well done to the boat’s crew!

Seriously, it’s nice to see that the *Maritime Engineering Journal* has developed a profile beyond its DND circulation. I’m sure that this kind of recognition goes a long way toward raising the credibility of your own staff and the navy’s marine engineering community….

Keep up the good work! **— Lt(N) Erick DeOliveira, Project Manager NESTRA, DMSS 8-5-5, Ottawa.**

(We) are...happy to hear that your team has won the 1999/2000 Merit Award for the quality of your editing work. We are also thankful to you for sending us a copy of the magazine on a regular basis…. Congratulations. **— Pat Emery, NLK Consultants, Inc., Masson-Angers, Québec.**

Thank you so much for all the kind messages regarding our recent editing award. It was gratifying to see that the *Journal* can hold its own in peer-reviewed competition.

— Editor

News Briefs

ET Graduates of the HMCS *Halifax* "Train the Trainer" class. *Front row*: LS Mullin, LS Taylor and P2 Dreyer. *Middle*: MS Gilbert and P1 Desjardins. *Rear*: LS Bungay, P2 Musgrave and MS Montag.

HMCS *Halifax* — Big on Training

HMCS *Halifax* (FFH-330) took time on a recent transatlantic voyage to train more than half her crew in the operation and maintenance of the ship's new solid waste handling equipment. The equipment — being installed on the frigates and AORs — consists of a pulper, a solid waste shredder, two compress melt units, and one closed-loop cooling unit. The new gear handles a ship's food, paper, cardboard, metal, glass and plastic waste streams.

One hundred and twenty-eight of *Halifax*'s 231 officers and non-commissioned crew completed training on the equipment from July 28 to August 3 while the ship, under the command of **Cdr Yves Bastien**, was en route from St. John's, Newfoundland to Århus, Denmark to join NATO's Standing Naval Force Atlantic. This was the largest percentage of a single ship's company to be trained on the new solid waste handling gear during the equipment's set-to-work period.

SLt Wayne Moore and Coxswain **CPO1 Kenneth Fisher** took the lead in setting up the aggressive on-board training schedule. A four-hour training session was set up for the electronics technicians and engine-room technicians on the operation and maintenance of the new equipment, after which two-hour crew operator training classes were conducted four times a day for anywhere from four to seven personnel at a time. NDHQ technologist George Power, a specialist with the DMSS 4 Environmental Systems section of DGMEPM in Ottawa conducted training on the solid waste pulper, while field support representatives **Ken Marszalek** and **Eugene Caruso** from Geo-Centers, Inc. of Pittsburgh, Pennsylvania led the training on the plastic waste processing equipment.

When *Halifax*'s Electrical Technician section volunteered to act as the ship's trainers for the new suite of equipment, a separate evening class was conducted to "train the trainers." As senior **ET PO1 John Desjardins** expressed it: the ETs are the equipment maintainers and have a very large stake in how the equipment is operated and cleaned. If they can train the crew in the correct operation and cleaning of the solid waste handling equipment, they can expect a reduced workload because the equipment will have been operated properly.

To date, the new solid waste handling equipment has been installed and set-to-work in nine of 14 ships. The remaining five ships will be completed by July, 2001. **— George Power, DMSS 4 Ottawa.**

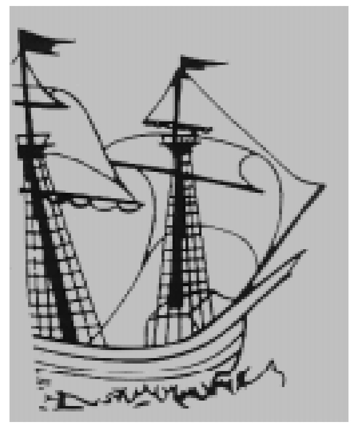
National Defence / Défense nationale

SUMMER 2000

News

CANADIAN NAVAL TECHNICAL HISTORY ASSOCIATION

Nautical Research Alive and Well in Canada



The Canadian Nautical Research Society held its Conference & Annual General Meeting at HMCS *Carleton* in Ottawa, June 8-10, 2000. The theme of "Maritime Moments of the Millennium" was purposely all-embracing, and the range of papers reflected that intent. Two of the eight sessions were devoted to the Royal Canadian Navy, with others covering the gamut from "The Age of Exploration" to "Life and Faith on the Bounding Main."

Although there were no papers specifically devoted to technical subjects, it was not for lack of interest in those areas. The final session, "Into the New Millennium," included two papers of interest to the CNTHA: Walter Lewis, "*The Emerging Role of the Internet and the Digital Library as a Tool for Researchers of Canada's Maritime History*," and Daniel LaRoche, "*Commemoration of Ships and Shipwrecks in Canada: An Uncertain Research Approach*." The latter included discussion of the many former Canadian naval vessels sunk in recent years as artificial reefs.

Many CNTHA members were in attendance, but there is room in the Society for many more. The CNRS was established to foster the multi-disciplinary study of maritime subjects in and about Canada. Annual membership (individuals, $45) includes subscription to the Society's quarterly publications. Our journal, *The Northern Mariner / Le Marin du nord*, contains a wide variety of articles and research notes, and reviews more than 300 new books each year. The newsletter, *Argonauta*, provides additional articles, news and information about maritime history worldwide. The CNRS is affiliated with the International Commission of Maritime History (ICMH).

Keep posted for details of next year's conference, which will be held at the Maritime Museum of the Great Lakes in Kingston, Ontario. For more information, visit our Website at http://www.mun.ca/mhp/cnrs.html – or contact me at 49 South Park Drive, Blackburn Hamlet, ON, K1B 3B8, e-mail: richmag@infonet.ca.

— LCdr Richard Gimblett
Secretary, CNRS

Inside this issue:

CNTHA News *Est. 1997*

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NC-1 Plot Table Fire

I joined HMCS *Haida* as Electrical Officer in December 1959 just as the ship was completing a fairly extensive refit. The overhaul saw major changes made to the Operations Room equipment in conjunction with an update to the gun fire-control systems. One piece of equipment new to the Ops Room was the transistorized NC-1 plot table, which was used for plotting target track information.

To visualize the mechanical operation of the plot table, it can best be thought of as an upside-down gantry crane, consisting of two parallel rails on which a carriage rolled back and forth. On the carriage was a light projector that indicated the ship's own position on the overhead plotting surface, and a device called the Target Plot Attachment (TPA) that was used to project the position of two targets (sonar/radar) relative to your own ship.

Unfortunately, not enough thought was given to the layout of the flexible wiring to this projector and its associated TPA. One day during operation of the plot table, the combination of carriage and projector movements conspired to catch the wiring around the edge of a rail and pull it tight enough to bare the wires. The resulting short-circuit caused a fire which burned most of the wiring inside the plot table. Fortunately, the ship carried similar spare wiring and one of my petty officer electricians was able to repair the damage, a job that occupied him for a considerable number of hours.

Subsequent to my submission of an Unsatisfactory Condition Report, two CANAVMOD (Canadian Naval Modification) instructions were issued. One dealt with an improvement to the flexible wiring layout and the other inserted fuse protection in the flexible wiring circuit. **— Pat Barnhouse, DSTM 3, Ottawa.**

About the CNTHA

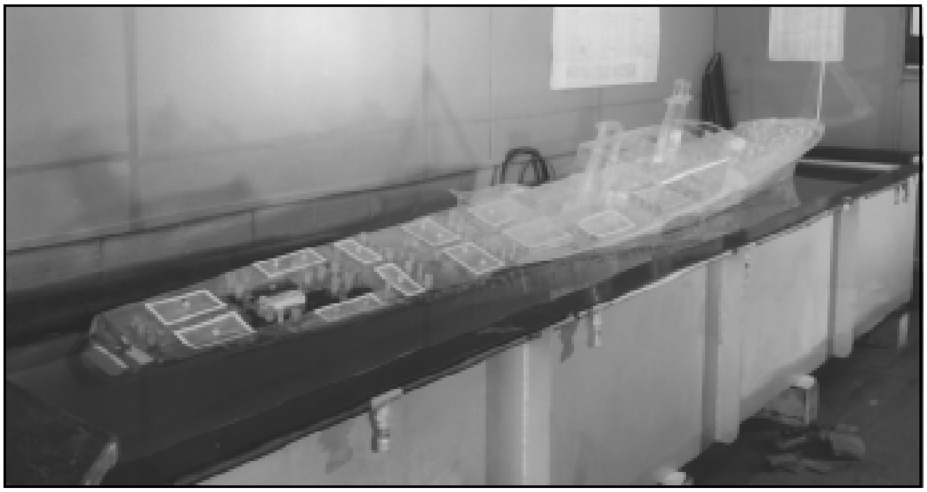
The Canadian Naval Technical History Association is a volunteer organization working in support of the Directorate of History and Heritage (DHH) effort to preserve our country's naval technical history. Interested persons may become members of the CNTHA by contacting DHH.

A prime purpose of the CNTHA is to make its information available to researchers and casual readers alike. So how can you get to read some of it? For the moment there is only one copy of the Collection, situated at the Directorate of History and Heritage located at 2429 Holly Lane (near the intersection of Heron and Walkley Roads) in Ottawa. DHH is open to the public every Tuesday and Wednesday 8:30-4:30. Staff is on hand to retrieve the information you request and to help in any way. Photocopy facilities are available on a self-serve basis. Access to the building requires a visitor's pass, easily obtained from the commissionaire at the front door. Copies of the index to the Collection may be obtained by writing to DHH.

The First RCN Transistors

In 1956 a subcontract was in place for Target Plot Attachments to operate with the NC-1 plotting tables then under production. The TPA used a magnetic servo-amplifier that was rugged and had no moving parts, but it had a drawback in that it was sensitive to temperature change and tended to lose linearity as the temperature varied even to a minor degree.

The prime contractor suggested using transistor servo-amplifiers, but they had no history of adherence to shock and vibration requirements. LCdr Carl Ross was in charge of the weapons section at Naval Service Headquarters, and after some head scratching considered that the reward was worth the risk — and so transistors entered service in the Royal Canadian Navy. They were as linear as vacuum tubes, were an immediate success, and paved the way for the use of modern electronic technology in the fleet. **— Phil Munro, Executive Director, CNTHA.**



How Stable *were* the Steamers?

Depending on how long you've been around, you might recall hearing claims that the *St. Laurent*-class and follow-on destroyer escorts built during the 1950s and sixties could survive a 360-degree roll without sinking. You probably dismissed the stories as so much folklore, but you might be surprised to learn that the information was pretty much spot-on.

How stable *were* the Cadillacs? In August 1955 Canadian Vickers Ltd. in Montreal ran trials to answer this very question. Engineers placed a 1.63 m Plexiglas model of HMCS *St. Laurent* in a water tank and simulated a variety of flooded conditions up to the point of sinking the ship. Their test rig allowed them to take direct readings of the overturning moment on the model, from which they constructed accurate stability curves for the ship.

According to the report written by Shipwright Lt.-Cdr C.T. Haynes, RN, the trial revealed some very interesting stability characteristics. For instance it was noted that the righting levers on the model increased markedly with larger angles of inclination. From this "…it may safely be concluded that the vessel does not lose transverse stability and is almost impossible to capsize, even under extreme conditions of flooding."

To establish this fact beyond question, the model was inclined to the point where upperdeck openings began submerging. In certain cases this allowed water to escape from already flooded compartments! At one point engineers actually rotated the model by hand to obtain a rough estimate of the angle of vanishing stability. "These observations alone, indicate that in all cases the stability of the ship remains positive even at an angle of heel exceeding 90 degrees," Haynes wrote.

Perhaps the most astounding statement in the report is the note at the end which reads: "The model was used without taking into account the reserve of buoyancy contained in the superstructure of the ship if maintained in a watertight condition. Thus these results are considered to be slightly pessimistic."

Predictably, the flooding trials were demonstrated to the captain and officers of HMCS *St. Laurent*. In those days before sophisticated computer modelling, a physical demonstration of a ship's stability certainly offered a measure of reassurance.

Of course, not all of us had the benefit of a first-hand demonstration. But then, we knew all along how good these ships were anyway...

...didn't we?

— Brian McCullough

Acknowledgement

The documents and photos associated with the *St. Laurent* stability model trials were submitted to the Canadian Naval Technical History Association by former DGMEPM Stability Officer **LCdr Garry Pettipas**.

Help us preserve Canada's naval technical heritage. If you have inactive files of naval technical documents you think might be better archived than trashed, you are encouraged to have them released to: **Michael Whitby, Chief of the Naval Team, Directorate of History and Heritage, NDHQ Ottawa, K1A 0K2**.

If you are unsure as to whether or not a file would be worth submitting to the CNTHA archives, please contact Michael Whitby at (613) 998-7045.

NATO Exhibit at Canadian War Museum

Canadian War Museum Photos by Bill Kent

One of the important legacies of Dr. J.L. Granatstein's tenure as Director and Chief Executive Officer of the Canadian War Museum is the permanent exhibit, "NATO: A Pledge for Peace and Progress." The exhibit opened on the third floor of 330 Sussex Drive in Ottawa in September 1999 to commemorate the fiftieth anniversary of the NATO alliance.

Dr. Granatstein's ambition was to bring a stronger historical storyline to the museum's exhibits, to reflect the latest historical scholarship. The existing displays on the post-Second World War era gave excellent coverage of peacekeeping, but did not sufficiently place this role in the context of the Cold War. The key point was to show that peacekeeping was just one task carried out by forces that had been raised and trained to a high professional pitch because of the foremost need for collective security.

The maritime forces component is located near the middle of the new 150-square-metre gallery to symbolize their central place in NATO — protecting the ocean frontiers of both Europe and North America, as well as safeguarding the sea communications between the two continents. Dr. Dean Oliver, senior historian at the war museum and the lead historian on the NATO project, drew on the work of the naval team at the Directorate of History and Heritage, including material gathered by the Canadian Naval Technical History Association in developing this part of the exhibit.

Although it was impossible to include large pieces of naval equipment in the display, a video kiosk has been set up that features clips on such Canadian naval technical achievements as variable depth sonar and the Beartrap helicopter landing system. **— Roger Sarty, Head of Historical Research and Exhibit Development, Canadian War Museum**

DND photo 71244

Mystery Solved!

In the Spring issue we ran a photo showing a mock-up of a *St. Laurent* hull compartment. There were three shipwrights in the photo, but there was one we couldn't identify. Fortunately, PO1 Mike Begallie, a hull technician in the Hull Standards section of Fleet School Esquimalt, has come up with a name:

> "You asked, 'Can anyone identify the man at the deadlight?' Well, in conjunction with CPO2 Joe St. Louis, we have identified this individual as **PO2 Peter Bossom** from a picture on the Hull Tech (Shipwright) Wall of Fame in Canadian Forces Fleet School Esquimalt."

Mystery solved, thank you, and another piece of our technical history has been "shored up."