National Defence Défense nationale

# Maritime Engineering Journal

*CANADA'S NAVAL TECHNICAL FORUM*

February 1998

## Greenspace Feature: The Navy's High Arctic Clean-up

## Also:

- *The Pareto Principle in Action*
- *Hunting the* Bismarck *– A Participant's Account*

Canada

# How to Simulate Shipboard Life —

E.D. McNally

## Suggestions for the ex-sailor who misses the "good old days"

# Maritime Engineering Journal

**Established 1982**


Director General
Maritime Equipment Program
Management
*Commodore J.R. Sylvester, CD*



**FEBRUARY 1998**



**Our Cover:**
Between 1994 and 1996, naval crews accomplished an extensive environmental clean-up of the navy's High Arctic surveillance sites. *(Photo by J.D.S MacLean)*


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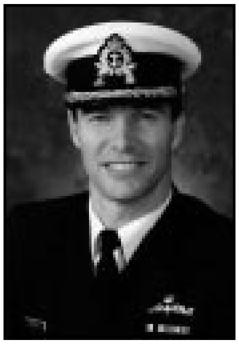


# Editor's Notes

## The Hidden Costs of Downsizing

By Captain(N) Sherm Embree, CD, P.Eng., CIMarE
Director of Maritime Management and Support — Editor

For the past seven or eight years National Defence has been downsizing. It has also been called "right sizing," "reengineering" and "reaping the peace dividend." Generally, we have been fitting within our budget, reducing the national deficit and demobilizing at the end of the Cold War. The navy has come through this period in a very positive fashion by having a renewed fleet (except for the lack of new submarines and shipborne helicopters), so we can be optimistic about our future. However, we should ask ourselves what have been the hidden costs of downsizing? Have we caught the bubble in this balancing act between savings and expenditures?

Although necessary, downsizing was neither an investment in capital capability nor in "flexible" personnel. Any nation's defence effort is a capital- and people-intensive endeavour, and defence departments in most countries are participating with their national governments in identifying how their capabilities can best be applied. Increasingly, governments are calling upon their militaries to respond to national peacetime needs with a disciplined labour force or personnel presence, rather than to respond to some offshore conflict with force of weapons. Even though the massive use of capital equipment is less necessary in our domestic taskings, the equipment must still be available. Not only must we have the necessary equipment to provide a general-purpose defence capability, but also to meet national concerns with fast, flexible and accurate communication and data delivery systems and the means for deploying large numbers of personnel (e.g. Saguenay and Manitoba flood relief and Ice Storm '98 assistance). Initiative, responsibility and co-operation are still characteristics to be sought, developed and maintained in all our personnel.

Have the personnel and capital implications of downsizing been realized? What are the hidden costs of downsizing? Futurist R.Worzel, author of "*The Next Twenty Years*" (Stoddart Publishing, Toronto, 1997) views them as excessive leanness, destroyed morale and lost creativity. If applied to DND, the hidden costs mean:

- **Capital Investment:** We must be cautious that DND does not become so lean it loses its flexibility to respond adequately to national and international commitments. DND's relationship with government would be negatively affected by limited capability. The challenge is to clearly define the government's desired level of operational capability, and have the government agree to provide adequate support capability for it — i.e. balance operations with the correct level of support;
- **Morale:** We must be careful that the "survivors" of downsizing do not burn out as they face an increased workload. They may not be able to respond, or may be unwilling to respond as they take on additional tasks. Morale could also suffer if survivors are given broad, or ill-defined long-term tasks that are impossible to be completed satisfactorily; and
- **Creativity** could be destroyed as the survivors continue to protect their job security or future prospects by keeping on their superiors' good side. This would lead to a vicious circle of reduced subordinate input, while trying to induce participatory leadership. Survivors may become unwilling to challenge their bosses or to raise innovative or risky ideas. There may be a temptation on the part of superiors to command rather than lead during and after downsizing. As senior officers and leaders we must guard ourselves against inappropriate leadership styles. The leadership qualities and creativity in a broad spectrum of our personnel could be affected.

The hidden costs of downsizing must be considered now, especially since reduction goals are in sight. Hopefully, the effects of the hidden costs have already been considered in the implementation of reengineering/downsizing initiatives. If not, we will be in catch-up mode to mitigate the effects of downsizing. That the navy ended up in a good capital position with two new classes of ship and an upgraded ship class eight years after the end of the Cold War is more a result of good luck than good design. We have yet to assess whether we have made sufficient investment to achieve a sustainable balance between operations capability and support capability during the cost-cutting. Thus, mitigating the effects of downsizing capital investment will fall largely upon the shoulders of the support community. This must be done in teamwork with the operational community to ensure we establish a general-purpose combat capable fleet to meet the government's national security needs and demands.

With respect to personal reactions to downsizing, indifference seems to have characterized the public's interest in National Defence during and after the downsizing. Since few outside of DND seem to care, just so long as the reductions are achieved, the government has been free to shift its focus elsewhere. Hopefully indifference is not reflected in our members despite the pressures on our morale, creativity and optimism. With a continuing sense of responsibility, creativity and co-operation our capital equipment needs can be met. Certainly the first battle in the war against the hidden costs of downsizing is to recognize and acknowledge the costs, then to be sure we are active in countering them.

**The editorial staff join the rest of the Maritime Engineering community in offering best wishes to Capt(N) Embree on the occasion of his retirement from the navy after more than 32 years of service.**

# Commodore's Corner

## Changes and Concerns

By Commodore J.R. Sylvester, CD
Director General Maritime Equipment Program Management

The new year has brought changes to this "corner" of the *Journal.* The previous "commodore-in-the corner," Cmdre Wayne Gibson, was promoted rear-admiral on New Year's Day and has taken up a new appointment as Commander of the Canadian Defence Liaison Staff in Washington, DC. On behalf of all our readership, I would like to thank RAdm Gibson for his insightful leadership and guidance, and wish him all the best in his new appointment.

Similarly, I would like to extend heartfelt appreciation to outgoing *Journal* editor Capt(N) Sherm Embree, who has taken his retirement. Throughout his career, Sherm provided valuable support to the *Journal*, the Division, his community and the navy. I would also like to bid welcome to Capt(N) Roger Westwood as he takes his place in the editorial slot as the new DMMS.

I am honoured to have been appointed to the navy's senior engineering position, and look forward to the many challenges presently with us and to those that await us. That being said, I arrive with neither a "new broom" nor a "reluctance to change." I will continue to press forward with initiatives that strive to balance work delivery against a shrinking budget and fewer personnel on all fronts. Foremost, I support the proven tenet that continued success depends on building partnerships across our organizational boundaries, and equipping our defence team members with the tools and training they need to get the job done.

In January I had the pleasure of visiting Esquimalt to participate in the successful and very interesting naval engineering seminar hosted by Capt(N) Dave Jacobson, CO of FMF *Cape Breton*. A meeting of the MARE Council, which I had the privilege of chairing for the first time, was held on the day prior to the seminar. The main purpose of the Council meeting was to discuss the issues and concerns facing our naval technicians and junior MARE officers (a full report of the minutes of this meeting will be posted on the DGMEPM website located on the DND DIN intranet at http://skeena.d-ndhq.dnd.ca/). Throughout the day's discussions and during the seminar that followed it was evident that the current situation of "reengineering" and "downsizing" has created increased anxiety and frustration for our people. At the same time, improved economic conditions in the private sector have made a departure from the Forces all the more tempting. A common thread throughout these discussions was the lack of trust in the organization and in senior officers to take action to alleviate people's concerns relating to advancement prospects, pay, job security, increased workloads and geographic stability. Not surprisingly, I hear much the same message from our civilian members within the Division and at the Fleet Maintenance Facility National Union Consultation Committee, which I co-chair.

Let me assure you, your concerns are not being ignored. The message from naval technicians and junior officers — from all of you — is getting through and being acted upon to the degree possible. The best reassurance is in positive results. In February, for example, the Chief of Maritime Staff held a special Naval Board devoted to these concerns. As many of these problems are pan-navy in nature, there is a need to find solutions that are, whenever possible, relevant throughout the Service.

MARE Council members will continue to address the issues in their individual capacities, as will the Branch Adviser in pursuing them with CMS and other staffs. However, I noted the frustration shared by Council members in not being able to directly resolve the problems and concerns facing our naval technicians and junior officers. The Council has no executive authority other than that which the individual members bring to the table by virtue of their primary duties. At the end of the day, we were left with a number of questions to consider concerning the future of the MARE Council. Is it time to rethink the nature of the Council and its relevance in today's navy? Are there better ways to look after the interests of our people? Can senior MARE officers use other means to effect necessary change so that the technical requirements of the fleet and the individual needs of our people can be satisfied?

In closing, we must keep in mind that all is not "doom and gloom." We live in and support an outstanding country. The navy has transited difficult waters before, and will do so again. We now have a modern fleet of warships in the early years of their in-service phase. Work remains, opportunities for interesting jobs abound, and the navy, as ever, requires our support.

Cmdre Jim Sylvester was born in Ottawa and educated in British Columbia and Ontario where he completed an engineering program at the University of Toronto (B.A.Sc. 1975; M.A.Sc. 1977). His military education comprised marine engineering subjects at the Royal Naval Engineering College (1978-79); professional military courses at the CF Command and Staff College (1985-86); second language training (1989-90); and security studies at National Defence College (1991-92).

Cmdre Sylvester enrolled in the Regular Officer Training Plan in 1972 and was commissioned in 1975. Following classification training in Canada and the U.K., he was awarded a certificate of competency in Marine Engineering (1980) before taking up positions as Deputy EO of HMCS *Iroquois*; Gas Turbine/Controls Officer of the CF Fleet School; and EO of *Athabaskan.*

In 1986 Cmdre Sylvester was posted to NDHQ to assume section head responsibilities for maritime maintenance policy and administration (1986-89) and for ship systems engineering in the CPF Project (1990-91). He was promoted captain in 1991, and in 1992 was appointed CPF Deputy Project Manager, and later Project Manager in 1994. Last December, shortly after joining the newly established Chief of Maritime Staff as DG Maritime Materiel, Cmdre Sylvester was promoted to his present rank and appointed DGMEPM in the Materiel Group.

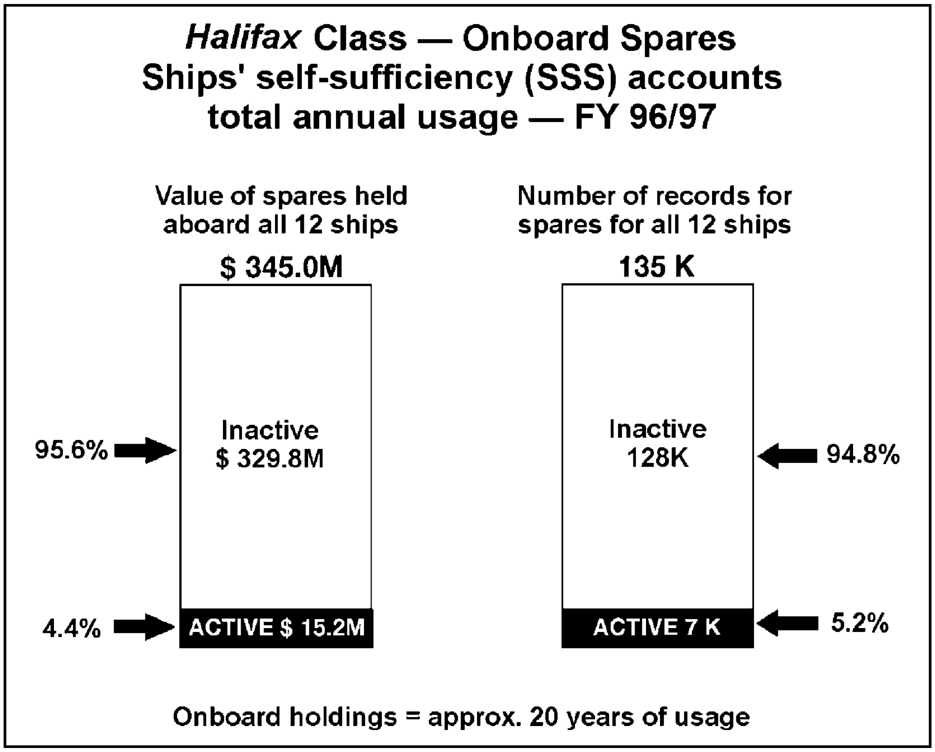
# After the Party is Over — Ongoing Logistic Support

Article by Cdr Bill Lewis

Canada recently took delivery of the last of 12 *Halifax*-class frigates, and completed acceptance of the four modernized *Iroquois*-class destroyers. Throughout the long construction and trials periods much of the focus for the logistics (maintenance and supply) staffs was on the establishment of onboard allowances, and on getting material from the vendors to the ships and into the supply system. Although there are still some outstanding spares packages to be received, this activity is winding down. Yet, just as the staffs were beginning to breathe easier and anticipating a reduction in high-priority demands for material, some unsettling statistics began surfacing to indicate that the introduction of the new and modernized ships had disrupted our normal level of logistics discipline. It is evident that, unless this supply discipline is reestablished quickly, we run the risk of spending an inordinate amount of time and money on spares support in the future.

Onboard spares are carried in support of preventive and corrective maintenance profile requirements. The onboard spares allowances have been carefully developed to reflect projected mean time between failures(MTBF), whether the equipment or part will be repaired by replacement (or otherwise), and whether this maintenance will be done ashore or afloat and by whom. The “logistics” system envisaged that repairable items would be promptly returned to the repair and overhaul pipeline, that ships and units would not demand more than their allowances permitted, that ships would use up their onboard stocks before making demands on their supporting base, and that, where warranted, allowances would be amended (up or down) to reflect real requirements.

For a variety of reasons that vision has never been realized. With the initial focus by the logistics staffs to get delinquent spares to the new ships, and the ships experiencing frustration with the support they were receiving, there was a tendency by the staff to be tolerant of the ships’ tendency to hoard what spares they had.



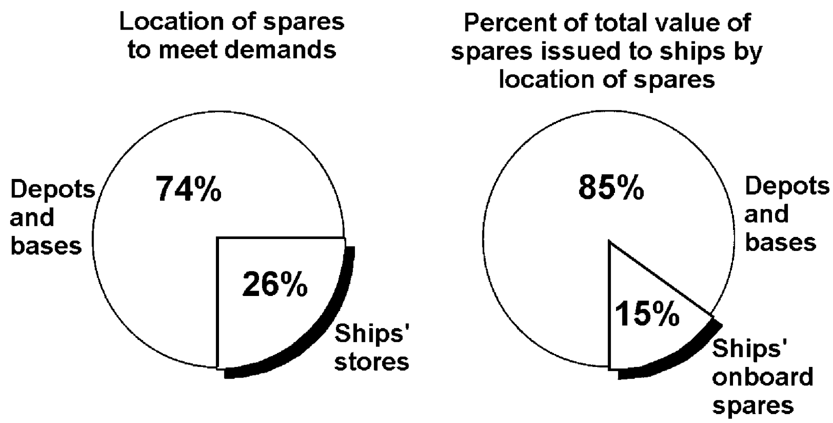

There now has been sufficient spares usage history to justify a review of spares holdings, etc. The time has come for a hard look at just how efficient and economical we have been in supporting the fleet, and take appropriate action to improve where opportunities exist.

The vehicle by which the logistics, technical and operations staffs are collectively involved in supporting the fleet to address concept design, consulting, maintenance, engineering configuration changes, repair and overhaul, disposal and spares procurement is the Fleet Support Plan (FSP). The FSP is designed to integrate and make visible all first-, second-, third- and fourth-line activities that support the fleet. An across-the-board review of these activities has indicated some disturbing trends which have resulted in, among other things, a larger than expected requirement by the fleet for recurring spares procurement and repair and overhaul.

Investigation by the staffs has found evidence that logistics discipline has eroded significantly. For example, some units were found to be carrying far in excess of their allowances, ordering spares items from Base Supply even though they still had stock on their shelves, thus denying easy access to these spares by others in need. In addition, the return of repairable items to the supply system has not been prompt. The bottom line is that, as a result of poor logistics management, we are investing in more inventory than is necessary, which diverts funding from other requirements.

It is also now evident that the usage of spares items has often been far below what onboard allowances provide for. There are many reasons for this, ranging from the MTBF being much longer in practice than was envisaged, to equipment maintenance being done ashore vice aboard as originally intended. Regardless of the reasons, the result is that the majority of the stock being held on board the ships is just not moving. In addition to it being uneconomical and inefficient to hold, it has the detrimental effect of tying up much-needed storage space and weight allowances aboard our ships. The *Halifax*-class ships are carrying about 20 years worth of spares on board. Can we afford the luxury of being so uneconomical and inefficient? Since the value of the onboard spares held in this one class of ship approximates $345 million, one could question why we are holding these slow-moving items on board instead of landing many of them to the supporting bases.

**_Halifax_ Class Spares Support — FY 96/97**
**Percentage by Location and Value Used by Location**




**Why are we holding $345M worth of spares aboard, if only 26% of the total spares requirements are satisfied from onboard spares holdings?**

Stock held in excess of requirements benefits no one. Whether the non-moving stock is aboard the ships or in the supporting base supply, it ties up space and incurs unnecessary carrying costs. Early identification of spares holdings that are surplus to requirements would allow logistics and technical staffs to investigate opportunities for additional efficiencies, such as returning spares to the vendors for credit, or even making them available to other nations (e.g. through the NATO Stock Holding and Asset Requirements Exchange "SHARE" program). Apart from freeing-up scarce dollars from unnecessary inventory holdings, early disposal of surplus material just makes good sense.

The restoration of logistics discipline must be addressed on two main fronts that encompass both supply and engineering disciplines. The first front (the easier of the two) has as its focus the target of making logistics support user activity more visible. We need to provide users with information pertaining to the number of repairable items they are not returning to the supply system for repair and overhaul work, the number of items they are holding in excess of allowances, the number of items they are demanding on the second line when first-line assets exist, etc. Once this information is visible we must demand accountability by the users for their practices.

The second front deals with the rationalization of the spares being held at units, bases and depots. This is a more complex task, but a critical one if there is to be significant improvement in efficient and economical support to the fleet. Thus, concurrent with the aforementioned action, it is also necessary that we examine carefully the usage history of the items, and rationalize this against the maintenance profiles for the equipment being supported. One aim of the maintenance review is to update the onboard and shore-based spares allowances to reflect both usage history and amended maintenance profiles. It may be tempting to look at spares usage history alone, but this only gives us a reasonable starting point. What is needed to complete the requirement is a review of specific equipment maintenance profiles. This maintenance review would, inter alia, confirm the requirements for the quantity and location of spares held for preventive and corrective maintenance over the long term.

Trying to improve logistics support on the "supply" net alone, ignoring the engineering and maintenance implications, would have significant long-term detrimental effects. Reducing inventory stock levels to reflect usage seems on the surface a logical activity, but one has to be cognizant of the reasons for low usage. It may well be that maintenance that was expected to be done aboard ship was, in fact, done ashore by the fleet maintenance facility or by the original equipment manufacturer. If the maintenance authorities are not satisfied with this approach and insist upon preventive maintenance being conducted on board, it would be counterproductive for all concerned if the applicable spares were to already have been landed. The overall approach must be "collegial" in that the offloading of inactive spares must be done in concert with a full review of the long-term maintenance activities for each equipment item. Only by doing so can we hope to ensure that the allowances are properly adjusted so that the right spares are available when required.

Canada's new and modernized ships have had enough time to generate sufficient spares usage data to support an in-depth review of our logistics discipline. This review would indicate that not only are several poor logistics practices evident, but that opportunities to improve the efficiency and economy of spares support also exist. We have generally been successful at getting the right part to the right place at the right time, but we have not been equally successful in maximizing the opportunities for doing so in the most efficient and economical manner. We cannot afford the luxury of inefficiencies and uneconomical support, as money spent on spares denies funding for improvements to the operational efficiency of the fleet. There is a significant challenge ahead to improve the logistics discipline and support to the fleet. We must do better.

*Cdr Bill Lewis is the DMMS 4 head of Supply Management Support in DGMEPM.*

# Validation of Engineering Training — A Team Effort

Article by Capt Bert Kendall

Validation is the process of measuring how well training has prepared graduates to perform their roles in an operational unit. It verifies, through consultation with graduates and their supervisors, whether or not the graduates have received, in a timely fashion, the appropriate knowledge and skills to perform the tasks associated with their jobs aboard ship.

For managers of training, information from a validation can be extremely valuable. It can indicate whether the design of the training is OK and whether training resources are being used efficiently. It can also indicate whether quantitative requirements are being met (i.e. whether the right numbers of people are being trained at the right time). The intent is to eliminate any unnecessary and overly expensive training.

In 1997 the Canadian Forces Naval Engineering School was tasked by the Chief Maritime Staff to validate its training. CFNES has since begun a methodical process of interviewing and mailing questionnaires to graduates of specific courses and their supervisors to determine whether the training being provided is meeting the needs of the fleet. The feedback is then analyzed and recommendations regarding the quality and/or quantity of training are made to the appropriate training managers.

This process points out the obvious — that effective validation requires the co-operation and support of the training establishment, its graduates, and the ship's leadership, particularly the graduates' immediate supervisors. It is only by getting feedback from all parties that students can be assured of receiving the training they need to do their jobs, and that the Canadian navy can be certain of receiving the trained sailors it needs to accomplish its missions.

If you are wondering what this "V" word really means to you, remember that one day it might be you who has to establish a requirement for training —a requirement that will be translated into specific knowledge/skill sets which we, as trainers, develop into courses. In an effort to determine if we are delivering a quality graduate, we are giving supervisors and graduates a chance to tell us how we are doing.

To date, our return rate for completed validation questionnaires has been mixed. The graduates seem to be showing a good deal of interest (their return rate is above 70 percent), but only 30 percent of the supervisors among you have been responding in kind, which prevents us from helping you as effectively as we could. Our hope is that, with a better understanding of our aims, the engineering community might participate more fully.

Essentially, if as a graduate you do not feel properly prepared for your job, take the time to tell us. Also, if you are a supervisor and feel that we have not imparted upon the graduate the knowledge and skill required for the job, or if the job has changed — tell us! Even if you aren't part of the sample selected, we are interested in your constructive feedback. We can be reached at the following addresses:

Mail: CFNES, Attention: Quality Assurance Validation Officer
Phone: (902) 427-0550 (ext. 6567)
Fax: (902) 427-8112 Attention: QA/Val O
MCAN: HNESQVA1 or look up Capt Kendall
Internet: HNESQVA1@marlant.hlfx.dnd.ca

*Capt Kendall is the Validation Officer at the Canadian Forces Naval Engineering School Halifax (CFNESH).*

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.

## Submission Formats

As a general rule, article submissions should not exceed 12 double-spaced pages of text. The preferred format is MS Word, or WordPerfect, on 3.5" diskette, accompanied by one copy of the typescript. The author's name, title, address and telephone number should appear on the first page. The last page should contain complete figure captions for all photographs and illustrations accompanying the article.

Photos and other artwork should not be incorporated with the typescript, but should be protected and inserted loose in the mailing envelope. If at all possible, electronic photographs and drawings should be in TIFF or JPEG format. A photograph of the author would be appreciated.

# Respect for Personnel is the Key to Trust in Leadership

Article by LCdr Ernest Nash

Capt(N) Mack in his article "Speaking the Unspeakable..." states that "Leaders must tackle the big issues in full view of...the community. They must speak the unspeakable... expose issues for all the greyness that these tough questions really are." To me this means that our leaders are going to set an example, that our leaders believe that our personnel are our greatest resource, and that our leaders are going to listen and react to what they hear and not necessarily just to what they want.

Capt(N) Mack states that trust can only be "regained by design." It is necessary to start this "design" soonest. Ask the questions and accept the answers. Truth is often a tough pill to swallow. Any recommendations, or changes that could come from a new "design" would most likely be met with an acute amount of skepticism considering that young sailors, POs and CPOs have indicated that "respect for superiors is low and leadership by example is disappearing."

This leads us to the heart of the matter. What are we willing to do? What are we willing to do without, or change? Who is willing to be first in line to ensure that we return to a position of trust? I submit that this must start at the top, with our superiors in the forefront.

An example of having our superiors lead by example happened during my time on board my first destroyer in 1974. The admiral of the day had visited us while the ship was participating in exercise NORPLOY '74 in Hudson's Bay. The CO was informed by the admiral that his ship was "not up to the fleet standard," and that this was to be rectified. The ship's company spent the rest of the deployment and the first few weeks after returning to Halifax bringing our ship up to what we believed to be the standard expected by the admiral. There was, however, a minor setback the week of the inspection. The admiral relayed to the CO that he would not be able to do an inspection after all. This was not acceptable to our CO and XO, and they immediately made representation to the admiral. What transpired during their visit to the flag building was never fully revealed, but the admiral made rounds of the ship on the appointed day.

> ***"…we must remember that in order to lead we must be able to follow, for in following we learn the requirements for leadership."***

How can we apply this lesson to today's environment? Twenty-four years have gone by, the political climate is very different and our expectations have changed. I'm certain the CO and XO of my first ship found, in 1974, that things were considerably different from when they joined the navy. However, I also believe that their principles, and how they saw themselves as leaders were the same in 1974 as when they joined. These two men, who no doubt remembered the important message of the Mainguy Report, saw it as their duty to their officers and men to stand up and be counted. If they perceived that an injustice was going to be inflicted on their ship's company, it was not going to be placidly accepted. In one significant act, where the possibility for personal reprisal was quite real, these two men cemented the respect and trust of their ship's company.

The "design" Capt(N) Mack envisions must be premised on what made the CO and XO of this ship trusted and respected —the conviction that absolutely nothing, including themselves, was more important than the welfare of their personnel, and their ability to confront, refuse to accept the status quo, and to say NO.

Capt(N) Mack's "design" should be implemented immediately, starting with a change in our collective mind set. I saw a good example recently of why we need some basic attitude adjustment. On the face of it, it didn't look like much — a reviewing officer was late for a well-advertised parade here in Ottawa. Was this his prerogative? Maybe. Did it show any respect for the personnel serving under him? None whatsoever. Avoidable incidents like this can have a lasting negative impact on people's faith in their superiors.

If any "design" is to have a chance at working, of leading us out of our dilemma, we must remember that in order to lead we must be able to follow, for in following we learn the requirements for leadership. Think not only how a policy will affect you, but also how it will affect your subordinates. Realize that the impact is different depending on whether you are a leading seaman, a chief petty officer, or an officer. By applying these few thoughts to the "design" we can ensure that what we decide is right and good and true, and that it is in the best interest of our people, and hence in the best interest of the navy.

*LCdr Nash is a Marine Systems Engineer in DMSS 3.*

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# The Misuse of Technology — Rebuttal

Article by LCdr Simon Hughes

I find Mr. Cyr's Forum article in the October '97 issue to be misleading, inaccurate and somewhat short-sighted in that it clearly lacks the broader, real-world operational experience it needs to be considered credible. We are only getting half the story.

His comments with respect to the "tracking of contacts in shipborne systems" need clarification. He gives the reader the impression that perhaps this is an unnecessary task, or that we did not even consider a better way of doing it. Well, we used to do it manually on a plot table and by grease pencil on an AN/SPA-25 display, but when ADLIPS came into being we had a machine that could attach symbology to targets and track them automatically for us. For the most part we stopped using the plot table or GOP. Then came the first DDH-280 CCS and its offspring, the modernized *Iroquois*- and *Halifax*-class command and control systems which use a much wider array of interfaced subsystems to automatically detect and track contacts. They also assign appropriate colour-coded symbology to contacts and perform other mundane tasks, such as CPA calculation and DROP TRACK of old, non-updating or invalid contacts. These improvements in technology have clearly changed the way we track contacts and the procedures used for blind pilotage, navigation, surface/air picture compilation, resolve, weapon assignment and engagement.

Mr. Cyr makes no acknowledgment of these facts and, instead, sticks to his premise that we continue to use "archaic methods that are heavily dependent on human intervention." He goes on to say that identification of threats "could best be performed by a machine in today's complicated combat environment...but the old ways and methods which are dependent on human input have been retained." For those of us who have seen the new CCS in action during operational exercises and missile exercises with friendly and hostile surface and air contacts and ROE in effect, human input is necessary. Currently, it has proven to be the only way to avoid an accident and the inevitable, unpleasant international political situation that would result from it.

Our command and control systems are simply not good enough to take into account the relevant geopolitical factors and ROE in effect, input them into their TEWA algorithms, account for all environmental and electronic conditions affecting tracking and classification of a target, perform warnings and ask for escalating ROE as the situation warrants. However, all these factors must be considered during the "resolve" procedure that determines whether or not a target has hostile intent and may, therefore, be subsequently tagged as hostile, put on the threat list and made engageable by the CCS. The technology we currently use cannot account for the friendly aircraft flying in unfriendly or controlled airspace without IFF. The CCS cannot make the distinction between contacts that are carrying weapons and contacts that are not carrying weapons. The only real TEWA algorithm that works is the one that resides in the "collective brain" of the combat team in HMC ships.

To say that "Canadian naval combat systems have not yet proven to be fatally unreliable because of their dependence on humans" is irresponsible, and makes me wonder whether Mr. Cyr understands how the *Iroquois*- and *Halifax*-class TEWA algorithm and battle doctrine work, or whether he recognizes their limitations. If Mr. Cyr were to have his way, he would have us sailing around with the CCS in AUTO all the time, apparently without a care in the world as to the potential for disaster created by that philosophy.

New technologies and integrated CCS have "dramatically improved system performance." Our naval methods and operational processes have indeed been rethought, retooled and reengineered as a result of the new technologies in the fleet. However, these modern systems have not yet demonstrated the ability to "think" and, until they do, Mr. Cyr's so-called "old ways...dependent on human intervention" will continue to be the only way we can safely conduct our business.

*LCdr Hughes is Sea Training (Atlantic)/ Combat Systems Engineer*

## 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.

# Arctic Clean-up — Interim ARCSSS Deactivation and Site Restoration

Article and photographs by J.D.S. MacLean

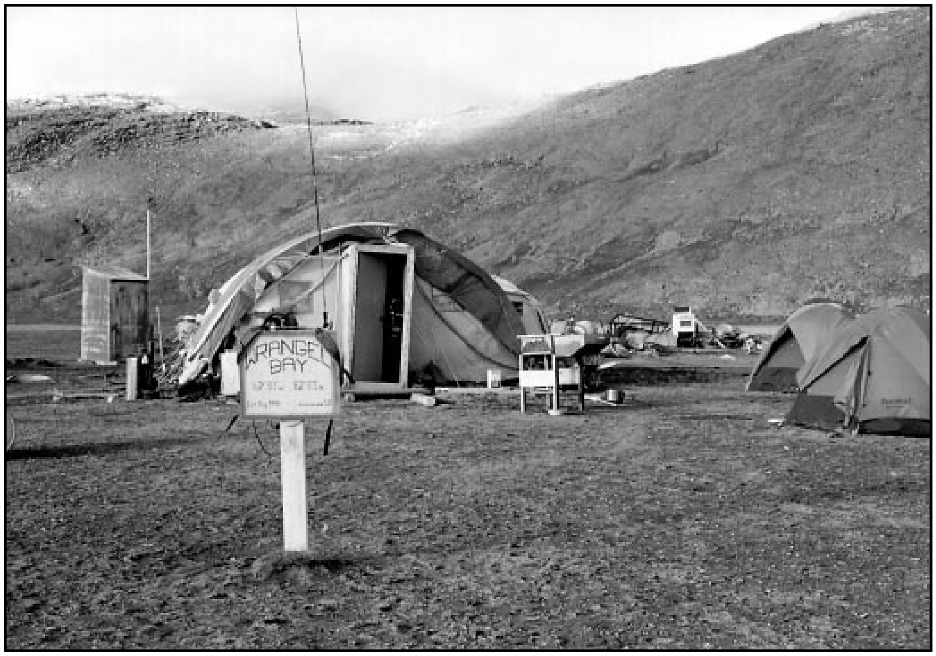
In June 1992 a team of personnel from the Directorate of Maritime Combat Systems (DMCS 3), the Directorate of Naval Requirements (DNR 3) and Defence Research Establishment Pacific (DREP) travelled to Wrangel Bay on the northeast coast of Ellesmere Island. Their task — to survey two interim sites of the Arctic Subsurface Surveillance System (ARCSSS — see *Maritime Engineering Journal*, June 1992, p.25).

Wrangel Bay was one of three interim sites established to provide acoustic data and a limited underwater surveillance capability in the High Arctic, and was the responsibility of the Director General Maritime Engineering and Maintenance. The other two sites, at Grise Fiord at the southern end of Ellesmere Island and Gascoyne Inlet at the southeast end of Devon Island, were the responsibility of DREP. The Grise Fiord system was deactivated and the site restored by DREP in the late 1980s, while the Gascoyne Inlet (Resolute) site was still active and producing data for analysis until its deactivation in 1996.

Acoustic data collection experiments had been conducted at Wrangel Bay since the early 1970s, with the last major sensor deployment being conducted in 1986 under the direction of DMCS 3 (now DMSS 7). The base camp established in support of the project was left intact, but after years of neglect the site had deteriorated to the extent that it constituted a potential environmental hazard. The 1992 survey report recommended actions to deactivate the interim system and restore the site, and DMCS 3-7 (Project Manager ARCSSS) was directed to assume this responsibility.

The main requirements of the Wrangel Bay/Gascoyne Inlet deactivation and restoration project were to:

- determine the resources required to remove the acoustic sensors and cables;
- remove equipment back to Alert for refurbishment, storage or disposal;




**Base Camp at Wrangel Bay, Northwest Territories.**

- remove the microwave repeater towers; and
- clean and muster the storage buildings at CFS Alert.

**Initial Work**

Research and planning began in the fall of 1993 and continued throughout the project until its completion in 1997. The project was divided into six phases, with the following objectives:

Phase One: determine requirements;
Phase Two: develop and confirm a plan with various agencies;
Phase Three: survey the sites;
Phase Four: verify requirements and resources;
Phase Five: deactivate and restore the sites; and
Phase Six: verify the clean-up.

The first iteration of the Wrangel Bay Deactivation and Site Restoration Plan was produced and forwarded for approval to the Director of Environmental Protection, Canadian Forces Northern Area Headquarters in Yellowknife, DNR and DMCS. Input was also solicited from Parks Canada, the Department of Fisheries and Oceans, the Archaeological Survey of Canada, the Northern Heritage Centre in Yellowknife, DREP (EDRD) and the Canadian Continental Polar Shelf Project. The plan was developed to provide maximum flexibility and would be updated and modified as required.

In order to clearly detail the level of clean-up and the environmental standards that would be required, a clean-up protocol was developed (see “Wrangel Bay Clean-up Protocol”). As the northern boundary of Ellesmere Island National Park Preserve intersects Wrangel Bay, Parks Canada was requested to advise us of any additional environmental standards they would like to see included as part of the clean-up.

Also, because of the dismal record DND had at the time with respect to archaeological sites in particular and Arctic operations in general, a great deal of effort was expended to ensure proper protection of local historic and prehistoric sites in Wrangel Bay. On the advice of

# Wrangel Bay Clean-up Protocol

The Wrangel Bay Clean-up (WBCU) Protocol was developed to satisfy environmental concerns resulting from the Wrangel Bay deactivation and site restoration. It was based on the DEW Line Clean-up Protocol endorsed by Environment Canada, Indian and Northern Affairs, Fisheries and Oceans, and the Government of the Northwest Territories. Any differences between this protocol and the DEW Line protocol were “in an upward direction” in favour of the environment. Since the Wrangel Bay site borders on the Ellesmere Island National Park Preserve, more stringent Parks Canada clean-up criteria were also included where practical.

The Protocol provided a strategy for dealing with chemical contamination, physical debris and site restoration at the base camp at Wrangel Bay. It also provided guidance for the protection of wildlife, flora and archaeological sites. Prior to working in the field, Wrangel Bay clean-up personnel were required to attend an orientation briefing covering, in part, safety issues and arctic ecology. A much-abbreviated summary of the Protocol covers:

**Contaminated Soils:** Soils containing contaminants in excess of established levels for the Arctic ecosystem shall be excavated and removed to CFS Alert for disposal. Special attention shall be given to soils that contaminate nearby aquatic environments even if the concentrations are below clean-up criteria. Excavation shall be done by hand, without the use of motorized heavy equipment. Visibly stained soils shall be excavated to a distance extending 0.5 m beyond the boundary of the stain.

**Debris and Hazardous Materials:** Debris shall be sorted into hazardous and non-hazardous components. Hazardous debris or waste may include: radioactive materials, toxic chemicals, dry cell and lead acid batteries, painted and chemically preserved wood, and ash produced by the combustion of these or other toxic materials. All materials and debris shall be removed to CFS Alert for proper disposal.

**Landfills:** Landfills located in unstable, high erosion areas shall be removed. Those in stable areas with no evidence of contaminated leachate shall remain as they are. Landfills producing contaminated leachate shall be removed and the contents treated as per contaminated soils, physical debris and hazardous material.

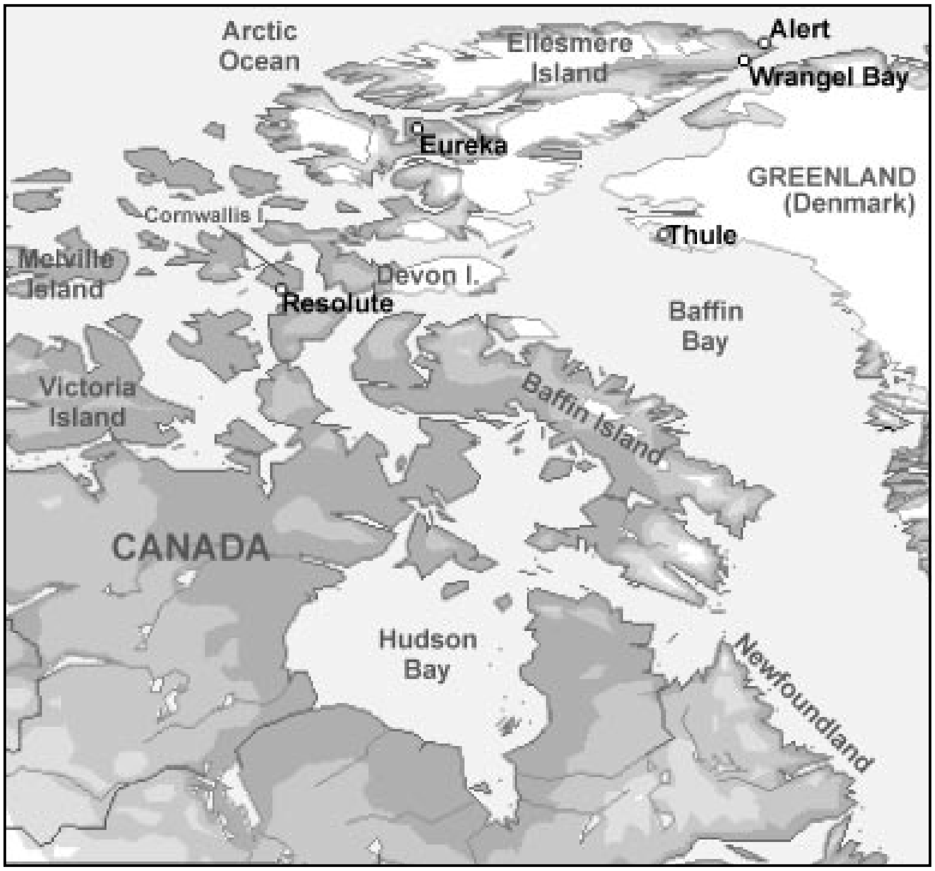
**Petroleum, Oil and Lubricants (POL):** All POL containers (including those for antifreeze, alcohol and solvents) shall be labelled and removed to CFS Alert for proper disposal. Spills of fuel or oil in excess of one litre shall be reported immediately to the on-site supervisor who shall commence remedial action. Contaminated soil shall be incinerated, the residue treated as hazardous material.

**Landlines and Underwater Cables:** The 65 km of landline between Wrangel Bay and CFS Alert will remain in situ until direction is received for its removal. The hydrophone cables, which are buried and covered in a one-metre-deep trench blasted across the beach and into the water, pose no ecological risk. As their removal would cause an unknown amount of environmental damage, they too shall remain in situ until direction is received for their removal. All landlines, hydrophone and ground cables shall be disconnected from the electronics shed and terminated in an easily recognizable protective container.

**Site Restoration:** Parcoll tents shall be dismantled and removed, with the exception of the mess tent which will be repaired, stocked with emergency supplies and left as part of the Arctic Safety Net. The latrine and incinerator will be left until such time as the mess tent is no longer required and removed. Areas disturbed by the removal of equipment or by other activities shall be restored to their original condition by contouring and levelling where possible.

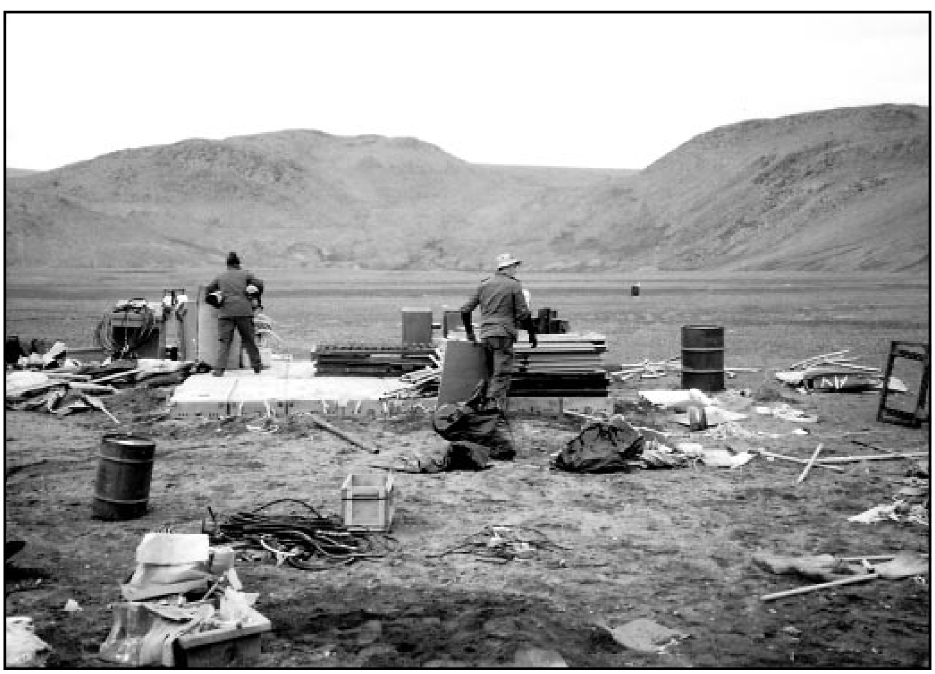
**Wildlife Protection:** Harassment or hunting of wildlife is not allowed. Birds’ nests shall not be disturbed. A flight path between Wrangel Bay and CFS Alert shall be selected to avoid vegetated areas and designated seabird colonies. Low flying, circling or repeated passes at any altitude to view or photograph terrestrial or marine wildlife is strictly forbidden.

**Historic and Prehistoric Resource Protection:** All known archaeological sites shall be avoided during clean-up activities. Fossils and archaeological finds discovered during the work shall be deemed to be the property of the Crown and reported. All reasonable precautions shall be taken to ensure that any such articles are not disturbed, damaged or removed from the site on which they are discovered and that the site is not damaged.




senior members of the archaeological community in Ottawa and the North, a satisfactory procedure was developed and included in the clean-up protocol.

On another front, both Parks Canada and the Canadian Wildlife Service expressed concern that the activities at Wrangel Bay would have a detrimental effect on marine and terrestrial wildlife. A section on wildlife protection was therefore included in the clean-up protocol and presented as part of a predeployment environmental sensitivity briefing given to all clean-up crews prior to departure for the Arctic. Pilots and crews of aircraft involved in the Wrangel Bay clean-up were also briefed.



**Organized chaos at Wrangel Bay.**

**Personnel and Logistic Support**

All operations or projects operating out of, or requiring logistic support from CFS Alert must make their requirements known in writing a year in advance to NDHQ Tunneys Ottawa DDS 7-3. This is followed by a formal presentation to the annual CFS Alert Projects Co-ordinating Meeting held at CFB Trenton in January each year (we made our presentation on on Jan. 12, 1994). All details concerning personnel, rations, quarters, transport, equipment, communications, airlift, weapons and ammunition requirements are presented at this time, including transport to and from CFS Alert.

Initial research indicated there would be a requirement for 15-20 personnel in Wrangel Bay for three to four weeks as late in the summer as possible. We had a number of options for obtaining manpower for the clean-up, but for various reasons we decided to use regular navy volunteers from the fleet. Once a list was established, temporary duty messages were cut and visit clearances were processed for CFS Alert. Arctic clothing was issued by CFB Halifax Base Clothing, after which the volunteers were transported to Ottawa for a final equipment check before proceeding to our jumping off point of CFB Trenton.

**1994 Site Survey**

In mid-June, 1994 a team consisting of Mr. J. MacLean (the DMCS 3 project manager) and PO1 G. Schultz from MARCOM travelled to Wrangel Bay to make a complete survey and inventory of the base camp. At the time the site had on it eight Parcoll tents, including a mess tent and cooking facilities, an equipment shack, two 30-foot catamarans fitted with hydraulic cable reels, power units and twin outboard motors, a diesel generator and power cables on the ungroomed runway. Several tonnes of loose gear (barrels, antennas, anchors, buoys spare parts and containers) lay in the vicinity of the camp.

It was also our job to determine what would be stored, overhauled, disposed of, or brought south. We had to establish what would be required for the clean-up, note the condition of the landing strip, and decide how best to repair the mess tent. Time permitting, we would also ascertain if the deployed hydrophones were still operational, and photograph the entire site to aid in follow-on planning.

The survey revealed that all Parcoll shelters, including the mess tent, were seriously damaged. We spent most of our scheduled two days removing snow and

**Water and air: Navy teamwork and outstanding air support proved to be the winning combination during the Wrangel Bay and Gascoyne Inlet clean-up operations. Author Jim MacLean (wearing the sunglasses) is kneeling at right with the rest of the August 1994 crew and their Twin Otter pilot.**

ice from the tents, patching holes and repairing the cooking facilities and heaters in the mess tent in preparation for the arrival of the clean-up crew in August.

A storm blew in the evening before our scheduled pick-up by helicopter, stranding us for an additional two days. On June 18, we busied ourselves instead with opening up the collapsed tents to allow sun and wind to melt interior snow, and with moving the hydraulic power units into tent no. 7 for better protection. We also refurbished the tools in a toolbox that we discovered frozen in the ice in one of the tents, made a POL (petroleum, oil and lubricants) check of the site, and conducted a complete photographic survey of the camp and surrounding area. We were finally picked up and returned to Alert by Twin Huey on the 19th.

**Site Deactivation and Restoration**
***1994 Operations***

The actual site deactivation and clean-up was conducted over three years, mainly because of the relatively short window of availability for aircraft support. Normally all work must be completed each year by June 30 (the end of Operation Hurricane), but the summer of 1994 was unique in that an additional 10-day window for shared aircraft resources opened up for us in August. We would be able to take advantage of fixed-wing and rotary wing assets under charter by a DREP/Continental Polar Shelf project being conducted out of CFS Alert.

The main objectives of Phase Five were to:

• repair the mess tent;
• dismantle and pack the remaining Parcoll tents;
• dismantle and pack the microwave repeater towers;
• collect and itemize all loose equipment for transport;
• prepare the catamarans for transport;
• collect and label all POL in approved containers;
• photograph the entire site to determine the amount of restoration required;
• record any environmental damage;
• secure and winterize the mess tent for use as part of the "Arctic Safety Net;" and
• secure backhauled equipment at CFS Alert.

The August '94 clean-up crew consisted of the DMCS 3 project manager and nine volunteers from Maritime Command. On arrival in Alert we were briefed on the standing orders unique to the station and shown to quarters. We were scheduled to depart for Wrangel Bay on Aug. 12 by Twin Otter, but poor runway conditions at Wrangel forced us to go by helicopter instead. A helicopter arranged through Polar Shelf came up from Resolute Bay the following day to take us out to the site in six loads.

Our first order of business was to organize the mess tent, refuel the stoves and heaters, and set up the sleeping tents. A preliminary survey revealed that the tool box we had rescued from the ice in June had been stolen from the mess tent, but we didn't discover this until the last flight had departed. The missing tools included everything from vise grips and tin snips to sailmaker's palms and a grommet kit. Fortunately, we had brought along extra vise grips and adjustable wrenches to supplement the toolbox, but it still caused a lot of problems. Also missing were the Wrangel Bay inventory sheets for this phase, the life jackets and most of the spares for the outboard motors.

During the first few days we were unable to raise Alert on HF radio, and our repeated attempts eventually depleted the battery packs. We jury rigged a makeshift battery from some old dry cells we found at the site and took the radio up the mountain to try to again. We couldn't raise Alert, but we did manage to establish a daily comm schedule with air-traffic control at Thule Greenland who offered to provide a message relay between Wrangel Bay and Alert.

We dismantled all the Parcoll shelters and moved the cable reels, fuel drums and outboard motors to the staging area. One box contained three 50-h.p. outboard motors, each weighing 100 kg. As the motors were bolted into the boxes and the proper tools to remove them were not available, we jacked the boxes up onto three empty propane tanks which we used as rollers to move the boxes into position.

With our pick-up scheduled for Aug. 20, we had to ensure the runway was serviceable. On Aug. 18 we decided to attempt to remove the catamaran from the end of the runway. We began by unwinding a kilometre or so of wire from the drum and flaking it out along the runway. Next, we pried the 200-kg drum off with 2x4s, pushed the winch off onto boards, and unbolted and removed the winch cradle and hydraulic motor. We rolled this lot up to the staging area where we reassembled the winch and rewound the wire onto the drum. We next removed the trusses and decking from the catamaran before jacking the pontoons (which weighed 1270 kg each) onto the empty propane bottles and rolling them to the staging area. This was an "all hands" evolution that took most of the day to complete.

Later in the day, the weather deteriorated steadily, with blowing snow and sand and 50-knot winds gusting to 85 knots. During the storm, part of the mess tent blew out and all but three of the sleeping tents were destroyed or sustained damage. We spent the remainder of the night and most of the next morning conducting damage control.

We spent August 19 collecting debris from the surrounding mountains and repairing and rebuilding the runway. The washed out areas were filled using shovels and a wheelbarrow, compacted by foot and leveled by dragging a bed frame loaded with rocks. A full day's work by five people yielded 350 metres of serviceable runway. The initiative and seamanship demonstrated by the crew during the storm and while dismantling and moving the heavy equipment validated the decision to use naval personnel.

Runway repairs were completed early on the 20th, with all personnel packed and ready to leave by 0900. When we reported in by radio, however, we were informed that a weather delay would postpone our pick-up to the next day. As the weather was again deteriorating, we made repairs to the mess tent and bunked down there for the night. At 0815 the next morning our Twin Otter overflew the site before making a successful landing with a few metres to spare.

All planned objectives for the 1994 season were met with the exception of the removal of the Parcoll bases. These were frozen in and could not be removed without heavier equipment or a substantial thaw time. No attempt was made to remove the landline or hydrophones.

***1995 Operations***

The 1995 operations at Wrangel Bay were conducted from June 21 to July 12 to coincide with the end of Op Hurricane and the northern phase of the High Arctic Data Communications Sys-

## Legislation and Regulations

Not surprisingly, we found that a dozen or more major legislative/regulatory documents had some impact on the preparation and progress of the ARCSSS clean-up project. We consulted everything from the Territorial Lands Act and Arctic Waters Pollution Prevention Act, to the Nunavut Settlement Area Land Claims Agreement and the Canadian Environmental Protection Act. Of all the agencies we dealt with, the one that can be expected to have the most significant future impact on DND activities in the Arctic is the Nunavut Impact Review Board, which screens all project proposals in terms of their environmental and socio-economic impact on the region.

A complete list of the legislative and regulatory documents we consulted, along with contact information for the many agencies we contacted for assistance and guidance during the project are contained in the final report held by DMSS 7.

**Mess tent repairs.**

tem (HADCS II) Survey. Our goal for this year was to complete phase five at Wrangel Bay and conduct a survey of the Gascoyne Inlet (Resolute Bay) site in preparation for deactivation and site restoration. The team for the Wrangel Bay site would consist of 10 people, while a three-member team would conduct the Resolute Bay survey.

Limited aircraft availability meant that no significant equipment backhaul to Alert was possible. With only an eight-day window, it was decided to concentrate effort on the following activities:

- excavate and remove the tent bases;
- excavate the landfill and remove all garbage and debris;
- dismantle catamaran no.2;
- sort and stage all equipment, scrap, POL, HAZMAT and contaminated soil for backhaul to Alert the following year;
- move the electronics hut up to the mess tent;
- proceed with repairs to the mess tent; and
- reestablish original drainage patterns.

Transport to Wrangel Bay was to be by Op Hurricane helicopters on June 23, but we decided to take advantage of a weather window and begin ferrying people and equipment from Alert to Wrangel Bay on the evening of the 22nd. The team had to scramble to collect the rations, weapons and ammunition, tools and equipment we required for our stay at Wrangel Bay.

The first of the team departed CFS Alert at 2030 hrs on the 22nd, with the last of five loads arriving at 0830 the following day. Once again, we immediately organized the mess tent and sleeping tents. A large snowdrift behind the mess tent was shovelled out to allow the tent bases

**Grunt work: The catamaran pontoons are dismantled and hauled into position before being airlifted back to CFS Alert.**

to thaw prior to their being removed. The ground around the exposed tent bases was excavated down to the permafrost to allow faster melting of the ice inside.

On June 23rd two helicopters arrived to begin removing some of the prestaged equipment back to Alert. The crew began disassembling catamaran no. 2 by pulling approximately three kilometres of cable off the reel by hand. The cable reel assembly was then disassembled and removed, and the struts and decking were unbolted. Work was halted at 2210 due to high winds and blowing snow.

On June 25th we chopped three tent bases out of the ice and burned them, along with nearly 700 litres of contaminated POL. We then dug up and removed 240 metres of landline as well as repeater no. 27. This section of landline was removed as a test to determine the level of effort required and also the amount of environmental damage that would result from its removal.

During the night of the 26th the winds picked up, damaging several of the sleeping tents and spreading insulation from the damaged sections of the mess tent over a large area. All remaining POL was consolidated and two more tent bases were chopped out and burned. Site remediation was carried out on tent base areas using our "bed frame grader/rake." We dragged the electronics hut on skids lubricated with snow over to the front of the mess tent. The wind continued to increase all day with a drop in temperature. Work ceased at 2115 due to high winds and blowing sand.

June 27th was spent performing site remediation on the remaining tent base areas and restoring the original drainage patterns. Two old landfill sites were excavated and the residue was placed in empty fuel drums. All residue from burning was also placed in drums. The remaining fuel drums were stacked and secured. Because the high winds, blowing snow and freezing rain continued throughout the day, the planned repair of the mess tent was postponed. A final skirmish was carried out in the camp and surrounding area.

On the morning of the 28th the sleeping tents were struck and secured, and the remainder of the equipment was made ready for removal and secured for the winter. Improving weather conditions allowed extensive repairs to be made to the mess tent prior to our returning to Alert.

All the objectives of the 1995 trip had been met. Granted, we had not removed the more than 60 km of landline and the underwater array, but we considered that it would have posed an unacceptable environmental risk to attempt to do so. All that remained to be done at Wrangel Bay was to remove the remaining staged equipment by helicopter during Op Hurricane the next spring. This would require a small crew to assist the loadmasters and move equipment.

**Order from the chaos: Everything including the kitchen broom was stacked neatly for removal.**

### *Gascoyne Inlet Survey*

The Gascoyne Inlet system consisted of three subsystems spread over five locations. The base camp (also known as Alpha camp and "Wet End") was located on Devon Island and consisted of four prefabricated plywood buildings (bunk house, cook house, electronics hut and generator/battery hut). There was also a microwave transmitter and antenna. The hydrophone cables were laid in a drilled sea/shore interface conduit and terminated in the electronics hut.

The South camp at Resolute Bay on Cornwallis Island contained a microwave receiver and the processing and recording facility. A microwave digital telemetry data link connecting the two camps consisted of three battery powered microwave repeater silos, one on Devon Island (Beta) and two on Cornwallis Island (Gamma and Delta).

On completion of the June/July '95 Wrangel Bay phase, the project manager continued on to Ft. Eureka to pick up transport to Resolute Bay for the site survey of the Gascoyne Inlet system. A meeting was held with the HADCS II Survey crew in Eureka to make final arrangements for the use of their aircraft while in Resolute Bay.

Two members of DMCS 3 and one from DREP formed the Gascoyne Inlet survey team. Once in Resolute, a meeting was held at the Polar Shelf offices with Mr. Dave Malloloy. As the area Crown Assets Disposal Authority, he would assist DND and DREP with the disposal of any equipment or material except HAZMAT.

We conducted a complete inventory and in-depth photographic survey of all sites comprising the Gascoyne Inlet system during the first two weeks of July 1995. All silos were found to be in surprisingly good shape. (We found a large polar bear waiting for us when we arrived at the Alpha site, but managed to chase him out with the helo.) On the return trip to Resolute the helo stopped at Beechey Island to let us visit the Franklin Expedition graves and monuments.

The survey report recommended that the electronics be deactivated and removed, but that the base camp at Gascoyne Inlet be left in situ as a resource for any government activities in the area. All DND, EDRD equipment and all HAZMAT was to be removed from the

# Lessons Learned

***Planning:*** Book transport to CFS Alert as early as possible. There are a restricted number of seats on the scheduled Hercules flights to Alert, and these are usually booked well in advance. Use “holding” names if you have to. Aircraft assets in the Arctic are scarce and expensive, so most operations are usually “piggy-backed” with other activities, even when there is commitment in writing. Have a contingency plan for every activity. Weather, communications, aircraft availability and changing priorities will frequently cause the best laid plans to change. Max flex!

***CFS Alert:*** Projects operating out of, or requiring the logistic support of CFS Alert must make their requirements known in writing a year in advance to NDHQ Tunneys Ottawa DDS 7-3. This is followed by a formal presentation to the CFS Alert Projects Co-ordinating Meeting held at CFB Trenton each January. All requirements for personnel, rations, quarters, transport, equipment, airlift (including equipment cube size and weight, if known), weapons and ammunition must be detailed at this time.

***CFB Trenton:*** Ensure crews have all the required clothing as per the Visit Clearance Advisory. If they don’t have the correct gear, they don’t get on the plane. Book the Yukon Lodge early as the nearest hotels are some distance away and it is difficult getting taxis for a large number of people and all their arctic gear at 0330 on the morning of the flight to Alert.

***Personnel:*** When soliciting volunteers or hiring crews, make sure there are back-ups in case of last-minute cancellations. Ensure personnel requiring medication inform the OPI, and bring enough meds to last three weeks more than the expected duration of the trip.

***Communications:*** If possible, borrow radio equipment and bring it north as suitable units are scarce in Alert and Resolute. A potential source of HF programmable radios (AN/URC-200) is the SRS Modernization Project at Tunneys Pasture, but these units are heavy and use two lithium batteries (NSN 6135-01-036-3495) which are classified HAZMAT 9.1 and are subject to special handling and shipping regulations.

***Messages and Correspondence:*** All messages and correspondence to DND and government addressees regarding activities to be conducted north of 60 degrees should be info addressed to: Commander Canadian Forces Northern Area HQ, Yellowknife, NWT.

**Helicopter support was essential to the operation.**

***Firearms:*** Note that all firearms taken into the NWT must have a permit and be sealed by a government official prior to being shipped. On arrival in the NWT the seal will be inspected, as it will again prior to your departure. Be prepared for much paperwork if a seal is ever broken. If a weapon is required for bear watch, arrange for a loan with Parks Canada (Alert) as far ahead as possible. In Resolute Bay, shotguns and ammunition can be signed out from Continental Polar Shelf near the airport. If for any reason a bear has to be killed, be aware of the current regulations regarding the disposition of the hide, meat and skull. These rules are rigidly enforced and may change drastically when the Nunavut Land Claims Agreement goes into effect.

***Wildlife:*** Prior to carrying out operations in the Arctic, check with the Canadian Wildlife Service as to the regulations concerning wildlife in your area. Also refer to the Wildlife Protection section of the full Wrangel Bay Clean-up Protocol for guidance. OPIs are responsible for the actions of the people and aircraft under their control.

***Emergency Rations:*** Ensure enough emergency rations are on hand in case people get left in the field. Since passengers are not allowed in helicopters slinging loads, loading crews must wait for the helo to return to pick them up. If the helo experiences mechanical problems or the weather deteriorates, a crew can be stranded for days. Never go anywhere in the Arctic by aircraft without a sleeping bag, a tent or portable shelter, a small emergency stove and enough rations for three days. Toilet paper is also a must as there are no bushes in the High Arctic. (A roll of toilet paper placed in a tin can and doused with diesel oil or aircraft fuel makes a good emergency stove and heat source.)

***Contractors:*** Some government contracts require that a percentage of labour, services and/or material be supplied by Inuit firms which qualify under Article 24 of the Nunavut Land Claims Agreement. D Env P holds an up-to-date listing of these firms.

***Alcohol:*** Alcohol sales in the NWT are strictly controlled, and some Inuit communities in the High Arctic are “dry.” In most cases spirits, wine and beer brought in for personal use are tolerated, but distribution and sale of alcohol to Inuit is absolutely forbidden. Check with the Government of the NWT on current regulations.

***Souvenirs:*** Items such as skulls, bones, teeth, fossils, artifacts, skins and hides found on the land or obtained from private sources must be cleared by local authorities (RCMP, Govt. of NWT, Parks Canada, etc.). A permit is required to possess these items, or to remove them from the NWT.

base camp, microwave repeater sites and the recording station in Resolute Bay. Removing the three microwave silos would require the close co-ordination of a number of agencies to properly prepare, remove, package and store nearly 1000 batteries, dismantle the silos and remove them to Resolute.

## 1996 Operations

### *Preparations for the Gascoyne Clean-up*

Planning for the Gascoyne Inlet deactivation was co-ordinated with the final stage of the Wrangel Bay clean-up. Helicopter and personnel support resources would tie in with the end of Operation Hurricane to reduce TD and operating costs and allow the same crew to complete clean-up activities in Wrangel Bay and Gascoyne Inlet. The major disadvantage with this arrangement was that the team would never have priority for an aircraft except in an emergency, which meant that we would have to react on short notice for aircraft availability.

Planning also began for the removal and disposal of HAZMAT from the Gascoyne Inlet sites. Battery manufacturer SAFT Canada provided a complete analysis of the contents of the batteries, and a meeting was held with DCEM 5 to determine the proper procedures for handling and disposing of potassium hydroxide batteries. DSRO Research and Technical Development was also contacted to obtain stock numbers for labels, stickers and containers for packaging, handling and shipping of the batteries.

A teleconference was established with the manufacturer of the potassium hydroxide neutralizer to establish a battery disposal plan. Once these procedures were established, they were validated with the procedures used by the HADCS II support team and Operation Hurricane personnel. An order was placed with Cartier Chemicals Ltd. of Montreal for 1900 kg (84 containers) of Vytac CS neutralizing agent.

A silo lifting bridle designed by the project manager and manufactured by FMF *Cape Scott* in Halifax was delivered to DMSS 7 during the first week of June. This would be prepositioned in Resolute along with the rations, clean-up equipment and neutralizer. A contingency plan for removing the batteries from the silos and Alpha camp was developed in case the helicopters were unable to lift the silos and battery huts in one piece. Protective clothing, face masks and safety equipment were also procured for the battery removal and neutralizing teams.

During the week of June 9th, through an agreement reached with CF Mapping and Charting Establishment and the Mould Bay Fuel Recovery Project, over 2300 kg of safety equipment, Vytac battery neutralizing agent and supplies were prepositioned in Resolute Bay. To reduce costs we took advantage of scheduled CF Hercules flights and flights of opportunity.

### *Wrangel Bay Completion*

The final stage of the Wrangel Bay clean-up and the removal of HAZMAT from the Gascoyne Inlet sites were scheduled to take place from June 16 to July 16, 1996. The two tasks were conducted serially to maximize clean-up crew efficiency, minimize transportation costs and take advantage of the availability of prepositioned helicopter resources at Resolute Bay.

Transport to Wrangel Bay was by the OP Hurricane helicopters. Two personnel were left behind in Alert to help offload the helos and sort equipment. At Wrangel Bay, all hands including the helo crews started making up loads for backhaul to Alert. Each helicopter (Bell 212 and Sikorski S61L) made four round trips on the first day, hauling a total of nearly 20,000 kg. The mess tent was then organized, stoves and heaters were fuelled, and we set up the sleeping tents.

On June 19th a soil survey of the entire site was conducted by the Environmental Engineering Research Group, Civil Engineering Department of the Royal Military College Kingston. A grid was laid over the entire camp, and 30 random soil samples were taken with emphasis on the fueling area and suspected contaminated areas. (The positive results of the survey were the final requirement for completing the project.)

During the day we backhauled 5000 kg of equipment and scrap to Alert by helicopter. That evening the weather deteriorated with high winds and drifting snow, and we spent the next day performing site remediation on the remaining equipment staging areas and restoring the original drainage patterns. The high winds, blowing snow and freezing rain continued throughout the day, so the planned repair of the mess tent was postponed until the following day. Damage control, final skirmish and preparation for departure were carried out until 0030.

**Attaching the lifting bridle to a silo.**

The next morning the sleeping tents were struck down and secured, and improved weather allowed us to finish the huge job of securing the mess tent. In addition to repairing the tent sections, we constructed a rear door in the electronics hut and joined the hut to the front lobby of the mess tent. The new joint and entrance were then sandbagged and banked with sand and gravel to protect the tent material and to prevent ingress of snow. The helos arrived at 1905 hrs to begin ferrying the crew and the final load of scrap and equipment back to Alert. In all, some 30,000 kg of equipment, scrap, POL and HAZMAT were removed from Wrangel Bay during that week.

All the objectives of the Wrangel Bay Deactivation and Site Restoration Plan were met, although the landline and underwater array were left in situ because of the environmental risk associated with removing them. The Wrangel Bay site now consists of a rebuilt Parcoll tent and wooden hut containing, among other small items, a propane stove and space heater, fuel, cooking utensils, tables and chairs, 24 boxes of individual meal pack (IMP) rations and various non-perishables. The site also holds a steel incinerator and and runway marker barrels (left at the request of Parks Canada). These items are now considered part of the Arctic Safety Net, available to anyone needing use of the facility.

Upon arrival at Alert we learned that our Herc flight to Resolute had been cancelled. Arrangements were made instead for us to travel to Eureka by helo the next day, June 22, then on to Resolute Bay by aircraft of opportunity. A chartered Twin Otter ferried the clean-up crew from Eureka to Resolute on the 23rd.

**Parking the silos at Resolute.**

### *Gascoyne Inlet Completion*

On completion of Op Hurricane at the end of June, aircraft requirements for the Gascoyne Inlet clean-up operation were dovetailed with Continental Polar Shelf Project taskings. We arrived in Resolute at 1645 on June 23, and the next morning I sent a fax to Brendan Donald of Esquimalt Defence Research Detachment (EDRD) informing him that we were ahead of schedule and to send a priority list of equipment to be removed from Alpha camp. A meeting was held with Dave Malloloy and Jim Godden of Polar Shelf to plan helo and support resources.

The crew was split into three teams: Team 1 (three people) would go to the Alpha camp to prep the batteries, all-terrain vehicles and generator; Team 2 (two people) would prep the silo batteries and rig the silo lifting bridle; Team 3 (two people) would stay in Resolute to offload the inbound batteries, silos and equipment. Polar Shelf told us at that time to park the silos and battery sheds at the end of the taxiway behind the EDRD (Steelox) building.

A planned overland trip to the Delta site to practice rigging the lifting bridle had to be cancelled due to the unusual amount of snow still on the ground. High winds grounded the smaller helos and forced the use of the Sikorski S61 to transport Team 2 to Delta to prep the batteries and rig the lifting bridle. Upon arrival at Delta, however, there was over a metre of snow on the mountain, which meant that the silo had to be shovelled out before the bridle could be attached. Unfortunately, the silo foot pads were frozen into the ground and could not be removed, so the upper locking wing-nuts were removed to allow the legs to slide up the footpad shafts when the silo was lifted. When the helo hooked on and lifted, however, the legs bound on the shafts, preventing the silo from moving. We rented acetylene gear from Narwhal Services to cut the shafts off just above the footpads.

Helicopter delays left me time to accompany Team 1 on the Twin Otter back to Resolute so I could assess the other three sites on the way. Alpha camp was heavily drifted around the buildings, but clear in the open areas. Beta was in the same condition as Delta (one metre of hard-packed snow), and Gamma was not visible due to bad weather in the area. Brendan Donald of EDRD arrived in Resolute at 1700.

On the morning of the 26th, Team 2 was dropped off at Delta to cut off the silo footpads and dig out the battery hut. At Alpha, meanwhile, Team 1 was rigging slings onto the 3700-kg snow tractor, which was then lifted back to Resolute. The helo refuelled and returned to Delta to remove the 3200-kg silo. On return from Resolute the S61 picked up Team 2 and transported us to Gamma before carrying on to pick up battery hut no. 1 from Alpha. After refuelling again, the S61 picked up the Gamma silo and delivered it to Resolute and returned for us at Gamma at 2100.

On arrival at Resolute I learned that a member of Team 1 had sustained a potassium hydroxide burn to his left eye and upper lip while off-loading batteries at Alpha. (He had not been wearing his protective face mask while handling the batteries. He was given first aid and evacuated by helicopter to the medical centre in Resolute. Later, he was flown to National Defence Medical Centre in Ottawa for further treatment, after which he returned to his unit.) Brendan Donald from EDRD went out to Alpha the following day to replace him.

On the 27th, Team 2 flew to Beta to prep the batteries and ready the silo for lifting. The S61 removed the Beta silo and a Bell 206 picked up Team 2 from the Beta Site and transported them to Alpha camp to relieve Team 1 (who returned to Resolute for a shower and a rest). Team 2 spent the remainder of the afternoon making up loads for the S61 and disposing of the pyrotechnics at the camp. At 1700 the S61 departed for Resolute with the final load (3000 kg on the hook and 550 kg inside.) Team 2 secured the camp for the winter and returned to Resolute.

By the morning of June 28, all HAZMAT and EDRD equipment from the four sites had been removed, with the exception of POL in the generator shed, 11 barrels of fuel and the ATCO trailer. Mr. Donald requested that these items be left at the site, stating that EDRD would accept responsibility for their removal if required at a later date. All unexpended ammunition cleared from the Alpha camp was turned over to the Resolute Bay RCMP. The 120 lead acid batteries, charger and shed at Delta were left until the following week when the ice would be melted sufficiently to allow them to be safely removed.

The remainder of the 28th was spent cleaning up the Steelox building in preparation for neutralizing batteries. Four plastic disposal tanks were borrowed from the Mapping and Charting Establishment's Fuel Clean-up Team, and three wooden pouring brackets and shrouds were built to fit the tops of the tanks. At 1800 the neutralizing area was set up and the first 60 batteries were trucked in. These were done in slow time to establish and perfect our neutralizing procedures.

The next day while we were neutralizing batteries, we were visited at the Steelox building by the Airport Manager, Mr. Dave Rayko. He had not been informed by Polar Shelf that we were parking our silos and battery huts on the end of the taxiway and wanted them moved. (We eventually bulldozed a storage area for the silos out of the drifts behind the Steelox building.) During the day, one of our battery neutralizing team sustained a KOH burn to his left hand through a small tear in his rubber glove. It was immediately treated with Vytac, flushed with fresh water and treated with flamazine.

We began noticing that an increasing number of batteries were not flushing out properly and were being bound up with a heavy grey sludge. These were set aside, flushed, refilled with water and left overnight to soak. By Monday, July 1 we were still neutralizing batteries and trying different methods for removing the sludge. That evening, the first silo was moved off the taxiway.

The following day the remainder of the new batteries were completed, with a total of 225 clogged batteries still soaking. A team of two was sent out to Delta on the Bell 206 to prep the 120 lead acid batteries and building. The remainder of the crew moved the second silo from the taxiway and prepared to receive batteries from Delta.

On July 3rd I contacted SAFT Canada for information on the sludge in the clogged batteries. They had not heard of this problem before and had no suggestions. I then called DCEM 5 to find out if they had encountered the same problem with the HADCS batteries. They had, but had no solution to offer. Instead, they sent a sample of the sludge to SAFT. We would have to package the clogged batteries and ship them south for disposal. That evening a team returned to Delta on the 206 to pick up the battery hut while the remainder of the crew removed the last silo from the taxiway.

**Neutralizing batteries was hazardous work.**

On July 4th the remainder of the batteries were neutralized and packed in tri-walls. The neutralizing tanks were taken to Narwhal, cleaned and steamed out and returned to the Mapping and Charting Establishment. All the empty Vytac containers were gathered up, filled with water and placed inside the silos as ballast to help offset the weight of the removed batteries.

The following day permission was granted to landfill the neutralized batteries. The contaminated batteries were then packaged for transport south (arrangements were made to have the Coast Guard fly them out by helicopter). The crew then moved on to South camp to dismantle and pack the Dry End electronics, recorders and spares. Arrangements were made to ship this equipment to EDRD by the first available Hercules. An agreement was also reached with Polar Shelf whereby they would include our lead acid batteries with theirs if we could find a suitable disposal site for them.

On July 6th all EDRD equipment was strapped onto a Herc pallet and marked for shipment. The Steelox building was cleaned, the floor decontaminated and the contaminated battery tri-walls strapped to pallets and marked with proper HAZMAT warning stickers. The HADCS radios were then packed for shipment and the crew baggage was taken to the airport for weigh-in. The remaining 17 unopened containers of Vytac were left in the Steelox building, from where they will eventually be taken to CFS Alert to be used in neutralizing the HADCS batteries.

With all DND equipment and HAZMAT removed from the Gascoyne Inlet system, the facility was now the responsibility of EDRD. At 1820 we de-

# The Cost of Cleaning-up

Total expenditures for the Wrangel Bay and Gascoyne Inlet clean-up activities came in at just under $200,000 — some $70,000 under budget. The breakdown was as follows:

- Preparation and Fabrication ($1,238)
- Aircraft Support ($158,229)
- Battery Disposal ($23,387)
- Temporary Duty and Travel ($16,470)

**Base camp at Wrangel Bay was a sprawl of damaged shelters, equipment and debris when the site was surveyed in 1994. The clean-up crews left it in considerably better shape two years later.**

parted Resolute and arrived in Calgary at 0020 via Cambridge Bay, Yellowknife and Edmonton.

**Conclusions/Acknowledgments**

Although most of the team members were unknown to each other at the beginning, they quickly adapted to the new environment and became a cohesive unit. Throughout the task they worked extremely well together under some very difficult conditions. Their "max flex" attitude allowed them to adapt to changing situations and schedules and maintain a high level of morale.

Throughout both phases of the trip, the co-operation and support of CFS Alert, Op Hurricane and Polar Shelf were outstanding. All personnel were friendly, courteous and willing to go out of their way to be helpful. This enabled the teams to fulfill the requirements of the tasks on short notice in spite of constantly changing weather, schedules and requirements.

It should also be mentioned that the co-operation and assistance provided by the Thule ATC played a vital role in the successful completion of this mission, as did the involvement of Maritime Command in screening and selecting volunteers for the work.

*Jim MacLean was the project manager for the ARCSSS interim site deactivation and clean-up. This article was adapted from his end-of-project report*.

# The Pareto Principle in Action: A Fleet Equipment Maintenance Cost Analysis*

Article by Lt(N) Ted Magtanong
(*From a presentation to the 1997 Eastern Region naval engineering seminar.)

In the next few minutes I would like to do two things:
a. share with you some FMF *Cape Scott* maintenance cost data for *Halifax*- and *Iroquois*-class ships; and
b. suggest a method for systematically reducing our current level of maintenance expenditure.

Why, you might be asking yourself, would anyone present such a dry subject?

DND is currently in a period of change and budget reduction. MARLANT's FY 97/98 ship/submarine budget was reduced by 32 percent, while its operating budget for FY 98/99 is being trimmed by $14 million. Eventually, the effects of these cuts will be felt by the fleet. Ships will have to contend with the cutbacks even though they have little or no control over the factors that affect their maintenance expenditures. Ships have no control over initial system design, nor do they have control over the preventive maintenance policies they are supposed to follow. Neither do they have the time, authority nor resources to engineer solutions to troublesome maintenance problems.

Problems do not disappear if you do not fix the root cause. Unless a significant change occurs to the system, which addresses the root cause of a problem, that problem is sure to reappear. Ships' staffs are busy ensuring the availability of their equipment. Rectifying the causes of certain maintenance problems would have the following two desired effects:

- reducing maintenance expenditures; and
- increasing equipment reliability and availability.

Before we can begin to reduce overall maintenance expenditure and increase equipment availability, however, we first have to determine where to focus our energy and resources. To do this we need data.

### Gathering the Data

There are many forms of data that show how poorly a ship system is performing. Operational deficiency messages are generated religiously at sea, but might not be sent when a ship is alongside. Furthermore, while unsatisfactory condition reports, preventive maintenance amendment proposals and pre-installation failure reports are necessary, I always found them tedious to submit. These reports are used by the life-cycle material manager to justify configuration changes and resource allocation. If no justification exists, very little attention is paid to the system. OPDEF, UCR, PMAP and PIF data may show the frequency of failure, but very seldom does it indicate the overall magnitude of a problem.

FMF *Cape Scott* (FMFCS) maintains a management information system that records all maintenance and equipment change installation tasks it performs. This data includes maintenance costs (in man-hours) and material costs. Both the frequency and magnitude of any failure can be identified.

We in the navy are notorious for recording all types of data. Stokers on watch record temperatures and pressures, technicians record pump performance, supply people record material costs. I have always felt, why take data if you never use it? Conversely, why not use the data if you have it?

I found some helpful conspirators within the business section of *Cape Scott*

**57-mm Gun**

| NEI | Corrective Maintenance | Preventive Maintenance | Configuration Changes | Total Man-hours |
|---|---|---|---|---|
| E26411 | 2,064 | 14,026 | 104 | 16,194 |
| E51501 | 80 | 0 | 3,612 | 3,692 |
| E28156 | 0 | 0 | 3,381 | 3,381 |
| E60149 | 178 | 0 | 2,990 | 3,168 |
| E51586 | 0 | 0 | 3,140 | 3,140 |
| E70270 | 2,195 | 548 | 0 | 2,743 |
| E69799 | 0 | 0 | 2,637 | 2,637 |
| E70321 | 1,176 | 1,246 | 0 | 2,422 |

**Fig. 1. Sample of *Halifax*-class NEI Maintenance Expenditure Breakdown in Man-hours (FY 96/97)**

to give me access to this type of data. Not knowing what to look for, I settled for a simple query. I asked Ms. Christine Haverstock to print out data showing Naval Equipment Index item numbers vs. total maintenance man-hours for *Halifax*-class ships for fiscal year 96/97. The data was ranked by total man-hours from highest to lowest. The total man-hour expenditures were comprised of corrective maintenance, preventive maintenance and configuration change tasks. *Figure 1* outlines a sample of the available data.

### The Pareto Principle

At this point I would like to explain a simple but important concept called the Pareto Principle, which states that 20 percent of all items (naval equipment items, or NEIs, in our case) will cause 80 percent of all failures (i.e. maintenance man-hour expenditures). I did the calculations for the *Halifax* class, but to provide a more realistic maintenance expenditure picture facing ships' staffs I first removed the man-hours for configuration change. Knowing that engineers like dealing with pictures, I graphed the man-hour expenditures for 448 NEIs as shown in *Fig. 2.* These expenditures do not include maintenance performed by ships' staffs. As expected, the graph shows a Pareto pattern.

To get actual cost figures, the man-hour expenditures need to be multiplied by the FMFCS charge-out rate of approximately $40 per hour. At $644 thousand, the MWM diesel engine accounted for the greatest single expenditure.

For the next set of data — NEI vs. maintenance material costs for fiscal year 96/97 — several databases were combined to provide material cost information on items purchased by FMFCS in performing its maintenance tasks. Note, however, that the cost of parts and equipment ordered by ships' staffs would not be recorded by FMFCS. Since this data is missing from the combined database, the material cost figures presented in this paper are lower than the actual costs.

### *Halifax* Class Data

Enough of generalities. Let's get into some specific NEIs. *Figure 3* shows, in ascending order, the top ten maintenance man-hour expenditure NEI systems. Note the increasing total man-hour expenditure. It is interesting to note that eight of these items were also observed within the top ten percent of the fiscal year 95/96 NEI vs. maintenance expenditure data. This tends to support the idea of the repeatable nature of these maintenance expenditures.

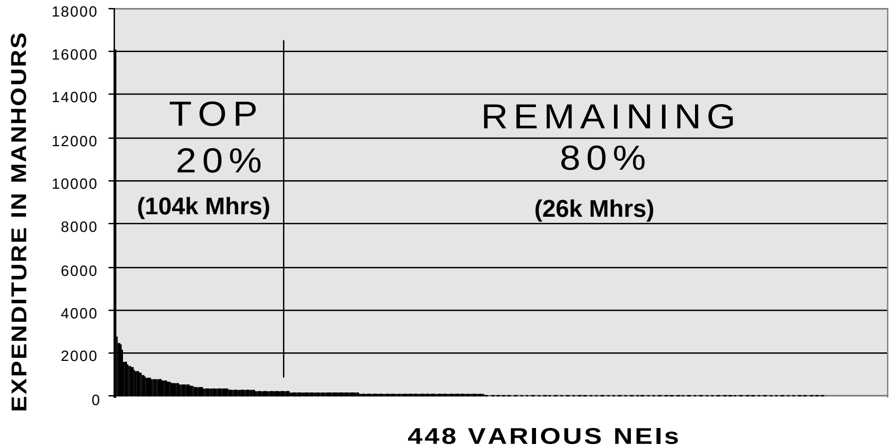



**Fig. 2. The Pareto Principle — *Halifax*-class NEI vs. Maintenance Man-hour Expenditure (FY 96/97) "The top 20% of NEIs are responsible for 80% of the total maintenance man-hour expenditure."**

*Figure 4* shows, in ascending order, the top ten *material cost* NEI systems. I have not included material cost comparison data from the previous year due to the overlapping nature of the data and the fear of double-counting material costs.

### *Iroquois* Class Data

Being a former *Iroquois* class officer at FMF *Cape Scott*, I did not want the *Iroquois*-class ships to be left out and so obtained the same maintenance man-hour expenditure and material cost data for these ships as well. Once again, the Pareto Principle was evident. The material costs were not as high as those for the *Halifax* class, but then there were only two *Iroquois*-class ships, vice six patrol frigates. Note in *Fig. 5* the increasing man-hour figures for the top five *Iroquois*-class maintenance expenditure NEI systems. (Only three of these items were observed within the top 10 percent of the NEI vs. maintenance expenditure data for fiscal year 95/96.) *Figure 6* shows, in ascending order, the top five *Iroquois*-class material cost NEI systems.

### Using the Pareto Principle to Advantage

If we know that the top 20 percent NEIs will cause 80 percent of all expenditures, it is possible to direct our resources to where they will have the greatest impact or benefit. Since the expenditure data exhibit this characteristic, there exists an ideal opportunity to target certain NEI systems as potential maintenance

| NEI | Material Cost ($) | Corrective Maintenance (Man-hours) | Preventive Maintenance (Man-hours) | Total CM/PM (Man-hours) |
|---|---|---|---|---|
| Bridge Windows | 44,138 | 1,332 | 0 | 1,332 |
| Aux. Boiler | 149,690 | 1,024 | 374 | 1,398 |
| Doors/ Hatches | 12,292 | 589 | 868 | 1,457 |
| Prop. Diesel Eng. | 278,304 | 364 | 1,195 | 1,559 |
| Stir FC Radar | 164,260 | 1,133 | 727 | 1,860 |
| Diesel Gen. | 51,236 | 1,879 | 72 | 1,951 |
| HP Air Dist. System | 3,406 | 2,153 | 0 | 2,153 |
| CIWS | 30,575 | 1,176 | 1,246 | 2,422 |
| 57-mm Gun | 16,047 | 2,195 | 549 | 2,744 |
| MWM Diesel Eng. | 2,723,429 | 2,064 | 14,026 | 16,090 |

**Fig. 3. Top Ten *Halifax*-class Maintenance Man-hour Expenditure NEI Systems (FY 96/97)**

cost-reduction candidates. *Figure 7* shows the maintenance and material costs for the top 10 percent and 20 percent NEIs for both classes of ship. It is unrealistic to eliminate these costs and expenditures entirely, but if we set a goal of reducing just the top 10 percent figures for each class by 30 percent, we could realistically save $2.9 million.

**Here's How**

Although similar maintenance data is available in NDHQ, there does not appear to be anyone using it in the global sense outlined in my presentation. Individual LCMMs are working in isolation, without any idea as to how their equipment is functioning relative to anyone else's. I propose that a group of two or three people be tasked to work with the LCMMs, FMFs and ships' staffs to review the existing data, investigate and provide recommendations to reduce the current level of maintenance expenditures.

For example, *Fig. 8* outlines a breakdown of preventive maintenance expenditures and material costs for the MWM diesel engine. The assigned team should be asking why there is a difference in completing various routines. After they have found the root cause, recommendations for minimizing the expenditure should be drafted. From just a brief discussion I had with the diesel inspectors at *Cape Scott*, we came up with the following suggestions:

- Conduct major maintenance based on condition rather than on running hours;
- Replace only those components which require replacement during major overhaul;
- Consolidate PM routines and rearrange so that inspection determines if PM is required;
- Use low-load injector in conjunction with heat run;
- Run diesel beyond manufacturer's recommended running hours prior to overhaul;
- Replace diesel with other prime mover;
- Replace diesel with other diesel;
- Increase generator size.

Recommendations such as these are useless unless acted upon. A suitable ship should be selected for the implementation of the recommended solutions similar to the current techval routine. Costs should be monitored to validate the recommendations.

| NEI | Material Cost ($) | Corrective Maintenance (Man-hours) | Preventive Maintenance (Man-hours) | Total CM/PM (Man-hours) |
|---|---|---|---|---|
| 85-ton Chiller | 88,084 | 1,516 | 717 | 2,233 |
| NBCD Filter | 89,296 | 8 | 61 | 69 |
| Auxiliary Boiler | 149,690 | 1,024 | 374 | 1,398 |
| SPS-49 Radar | 156,552 | 343 | 190 | 533 |
| Stir FC Radar | 164,260 | 1,133 | 727 | 1,860 |
| Gyro Systems | 184,939 | 138 | 0 | 138 |
| Shield CMs | 237,069 | 461 | 587 | 1,048 |
| Prop. Diesel Eng. | 278,304 | 364 | 1,195 | 1,559 |
| Air Search Radar | 1,286,361 | 1,781 | 183 | 1,964 |
| MWM Diesel Eng. | 2,723,429 | 2,064 | 14,026 | 16,090 |

**Fig. 4. Top Ten *Halifax*-class Material Cost NEI Systems (FY 96/97)**

| NEI | Material Cost ($) | Corrective Maintenance (Man-hours) | Preventive Maintenance (Man-hours) | Total CM/PM (Man-hours) |
|---|---|---|---|---|
| CIWS | 92,884 | 271 | 494 | 765 |
| Diesel Gen. | 4,658 | 807 | 0 | 807 |
| Degaussing System | 0 | 1,085 | 0 | 1,085 |
| VDS Hoist System | 20,003 | 2,932 | 268 | 3,200 |
| Diesel Engine | 16,143 | 3,932 | 0 | 3,932 |

**Fig. 5. Top Five *Iroquois*-class Maintenance Man-hour Expenditure NEI Systems**

| NEI | Material Cost ($) | Corrective Maintenance (Man-hours) | Preventive Maintenance (Man-hours) | Total CM/PM (Man-hours) |
|---|---|---|---|---|
| Variable Depth Sonar | 45,935 | 310 | 0 | 310 |
| Antenna Coupler | 50,000 | 15 | 0 | 15 |
| Close In Weapon System | 92,884 | 271 | 494 | 765 |
| Antenna Coupler Group | 95,455 | 138 | 0 | 138 |
| Radio Set | 153,319 | 395 | 0 | 395 |

**Fig. 6. Top Five *Iroquois*-class Material Cost NEI Systems**

If we do nothing and maintain the status quo, the exact same type of maintenance expenditures will continue to occur. This view is supported by historical data which shows the top NEIs continuing to rank among the top 10 percent of the previous year's data. Anyone who has seen Deming's red bean experiment will tell you that unless a significant system change occurs, the same level of expenditure will continue.

In conclusion, the major points of my presentation are as follows:

| | *Halifax* Class | *Iroquois* Class |
|---|---|---|
| Labour Hours (Top 10%) | $2.4M | $561K |
| Labour Hours (Top 20%) | $2.9M | $723K |
| Material Costs (Top 10%) | $5.7M | $1.1M |
| Material Costs (Top 20%) | $6.1M | $1.3M |

**Fig. 7. Maintenance and Material Costs for the top 10% and 20% NEIs for *Halifax* and *Iroquois* Classes**

| Customer | Job Title | Man-hours | Material Cost |
|---|---|---|---|
| 235 | No. 2 diesel 12-monthly routine | 23.5 | 0 |
| 235 | No. 1 diesel 12-monthly routine | 98.2 | $4,880 |
| 227 | No. 1 diesel 7,500-hour routine | 1, 199 | $8,415 |
| 227 | No. 3 diesel 7,500-hour routine | 125 | $8,584 |
| 231 | No. 4 diesel 7,500-hour routine | 1,782 | $9,496 |
| 231 | No. 2 diesel 7,500-hour routine | 1,399 | $63,506 |
| 228 | No. 1 diesel 7,500-hour routine | 31.5 | $233,621 |
| 232 | No. 1 diesel 7,500-hour routine | 2,032 | $259,989 |
| 232 | No. 4 diesel 7,500-hour routine | 1,985 | $267,680 |
| 230 | No. 1 diesel 15,000-hr routine | 4,753 | $612,819 |
| 230 | No. 3 diesel 15,000-hr routine | 4,000 | $1,245,110 |

**Fig. 8. MWM Diesel Engine Preventive Maintenance Expenditures (Sample Data)**

**MWM Diesel**

• Budget cuts are on the way;

• Maintenance man-hours and material costs are available to assist in locating troublesome maintenance problem areas;

• The impact of our resources can be maximized using the Pareto Principle;

• Recommendations have to be acted upon if any savings are to be realized;

• There exists an opportunity to reduce our current level of maintenance expenditures by $2.9 million.

**Bridge Window**

Before I open the floor to questions, I would like to read a quote by W.H. Murray:

"Until one is committed there is hesitancy, the chance to draw back, always ineffectiveness. Concerning all acts of initiative and creation, there is one elementary truth, the ignorance of which kills countless ideas and splendid plans — that moment one definitely commits oneself, then Providence moves too. All sorts of things occur that would never otherwise have occurred. A whole stream of events issue from the decision, raising in one's favour all manner of unforeseen incidents and meetings and material assistance which no man could have dreamt would have come his way. I have learned a deep respect for one of Goethe's couplets: 'Whatever you can do, or dream you can do, begin it. Boldness has genius, power and magic in it.'"[2]

## Acknowledgments

The author would like to acknowledge the contributions of the following FMFCS personnel: Ms. Christine Haverstock; Mr. Howard Miller; Mr. L.T. Taylor; Mr. Steve Dauphinee, Mr. Harry Bassett and LCdr Kevin Woodhouse.

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# How to Simulate Shipboard Life*

## Suggestions for the ex-sailor who misses the "good old days"

(* Reprinted with permission from the August 1997 edition of the FMF *Cape Scott* newsletter, *Great Scott Times*. According to *Times* editor LCdr Kevin Woodhouse, the item was received from a colleague serving on board the USS *Theodore Roosevelt*. "We have seen similar lists before," Woodhouse writes, "but I thought that we could get the USN slant this time. Enjoy!")

Sleep on the shelf in your closet.

Replace the closet door with a curtain.

Six hours after you go to sleep, have your wife whip open the curtain, shine a flashlight in your eyes, and mumble, "Sorry, wrong rack."

Renovate your bathroom. Build a wall across the middle of your bathtub and move the shower head down to chest level.

When you take showers, make sure you shut off the water while soaping.

Every time there's a thunderstorm, go sit in a wobbly rocking chair and rock as hard as you can until you're nauseous.

Put lube oil in your humidifier instead of water and set it to "High."

Don't watch TV except movies in the middle of the night. Also, have your family vote on which movie to watch, then show a different one.

Leave a lawn mower running in your living room 24 hours a day for proper noise level. (Mandatory for ex-engineering types.)

Once a week blow compressed air up through your chimney, making sure the wind carries the soot onto your neighbour's house. Laugh at him when he curses you.

Have the paper boy give you a haircut.

Buy a trash compactor and only use it once a week. Store up garbage in the other side of your bathtub.

Wake up every night at midnight and have a peanut butter and jelly sandwich on stale bread.

Make up your family menu a week ahead of time without looking in your food cabinets or refrigerator.

Set your alarm clock to go off at random times during the night. When it goes off, jump out of bed and get dressed as fast as you can, then run out into your yard and break out the garden hose.

Once a month take every major appliance completely apart and then put them back together.

Use 18 scoops of coffee per pot and allow it to sit for five or six hours before drinking.

Invite at least 85 people you don't really like to come and visit for a couple of months.

Have a fluorescent lamp installed on the bottom of your coffee table and lie under it to read books.

Raise the thresholds and lower the top sills on your front and back doors so that you either trip over the threshold or hit your head on the sill every time you pass through one of them.

Lockwire the lug nuts on your car.

When making cakes, prop up one side of the pan while it is baking. Then spread icing really thick on one side to level off the top.

Every so often, throw your cat into the swimming pool, shout "Man overboard, ship recovery!", run into the kitchen and sweep all the pots/pans/dishes off the counter onto the floor, then yell at your wife for not having the place "stowed for sea."

Put on the headphones from your stereo (don't plug them in). Go and stand in front of your stove. Say to nobody in particular, "Stove manned and ready." Stand there for three or four hours. Say, once again to nobody in particular, "Stove secured." Roll up the cord and put the headphones away.

Wartime Sketches by Lieut. Edwin Dean McNally, RCNVR

# The *Bismarck* Action of 1941 — Technical Recollections of a Participant

Article by S. Mathwin Davis, Ph.D; Rear Admiral (Ret.)
This article was sponsored by the Canadian Naval Technical History Association.

The action which led to the sinking of the German battleship *Bismarck* in 1941 was in various ways an unequal struggle. On the one hand was the vessel itself — a masterpiece of naval construction and, at 51,000 tons, far larger than might have been anticipated from the treaty "constraints" between the wars.

On the other was the ability of the British admiralty to call upon a wide range of fleet resources — in all, some five battleships, three battle-cruisers, two aircraft carriers, 13 cruisers, 33 destroyers and eight submarines. Most of these never came anywhere near *Bismarck* itself, but all were called into play in various areas of the Arctic, North Atlantic and Bay of Biscay. There were also, on both sides, significant technical elements that influenced the outcome of the engagement.

*Bismarck* was launched in February 1939, and by early 1941 the ship had completed extensive trials in the reasonably protected waters of the Baltic and was ready for operations. The German naval staff clearly could not envisage *Bismarck* joining a major fleet action, but the concept of using this vessel for operations against North Atlantic convoys was very attractive. It was therefore decided that *Bismarck* and the heavy cruiser *Prinz Eugen* should move out into the Atlantic (hopefully undetected) under the operational command of Admiral Günther Lütjens. Together the two capital ships would pursue their major objective of destroying Allied convoys, while avoiding risk of combat with forces of equal or greater strength.

So it was that, early on Monday May 19th, the vessels departed from Gotenhafen (Gdynia) on Exercise Rhine. There had, however, already been an apparently minor but potentially serious technical failure during fuelling on the 18th.

**Following the Bismarck action in 1941, the author posed for this photo with fiancée Lois Voas, an American Red Cross nurse serving with the "Harvard Unit" at Salisbury. The couple married in 1943.**

> *Although thousands of tons of fuel flowed into our bunkers, we could not fill them completely because a hose ruptured causing the fuelling operation to be called off so that the mess could be cleaned up.*[1]

At any event, the vessels proceeded to the North Sea via the Kattegat and Skagerrak where they were spotted on May 20th — first by the Swedish cruiser *Gotland*, and next off Kristiansand by members of the Norwegian resistance. It is an interesting question why they did not pass through the German controlled Kiel Canal directly into the North Sea, but for this we have no answer.[2]

The sightings were reported to the Admiralty, and while the identities of the ships were not known the Commander-in-Chief Home Fleet at Scapa Flow, Admiral Sir John Tovey, began dispositions on May 21st. The cruisers *Norfolk* and *Suffolk* were ordered to patrol the Denmark Strait, while *Hood* and *Prince of Wales* were dispatched to a covering position southwest of Iceland. Meanwhile, *Bismarck* and *Prinz Eugen* had put into a fjord near Bergen where the latter topped-off with fuel. Curiously, *Bismarck* — already somewhat short of fuel — did not seek to replenish, an omission that was to have serious consequences.

Of more immediate concern was a flight over Bergen by a photo-reconnaissance Spitfire which recorded the vessels' presence and provided positive evidence that it was *Bismarck* at large. After some delay due to fog and low cloud, it was determined on the evening of May 22nd that the German vessels had left Norway. Late that evening, Tovey set out in his flagship *King George V*, with *Victorious* and *Repulse* in company. The German vessels were now headed north-northwest and making for the Denmark Strait.

Around 1830 on May 23rd *Bismarck* and *Prinz Eugen* entered the Denmark Strait between the Greenland ice barrier and the declared minefields northwest of Iceland. Conditions were foggy, but within an hour *Suffolk* had picked up the enemy on her early model radar. Ironically, in a brief burst of gunfire against *Norfolk*, *Bismarck* put her own radar out of action.

The British cruisers now began shadowing the German vessels. For *Hood* and *Prince of Wales* approaching from the southeast early on May 24th, the situation was not favourable. They were making a lengthy approach, silhouetted against the sunrise and heading into fairly heavy weather. A well aimed salvo from *Bismarck* a few minutes into the action penetrated *Hood*'s lightly armoured deck and exploded a main magazine. As is generally known, *Hood* broke in half and sank immediately, with only three individuals surviving. Here it might be noted that *Hood*, built during World War I, was a battle-cruiser intended for operations against cruisers, and her armour had been sacrificed for armament and speed. She was supposed to have been fitted with additional armour during a major overhaul in 1939, but this had been cancelled.

In the brief action that followed, *Prince of Wales*, fresh from the contractors and with civilian workmen still on board, was having considerable trouble maintaining fire. The ship suffered damage to her bridge and withdrew, but not before putting one of *Bismarck*'s two boiler rooms out of action and, more seriously, breaching the German's hull right forward. *Bismarck* took on some 2,000 tons of sea water which could not be removed, and damage to pumps and valves meant that 1,000 tons of fuel was not available and indeed was leaking out, leaving a significant trail. With a nine degree list to port and nearly three degrees down by the head, *Bismarck*'s speed was reduced to 28 knots.

Admiral Lütjens now concluded that the intended operation could not continue and that he should release *Prinz Eugen* and make for St. Nazaire some 2,000 nautical miles away to effect repairs. With significant damage sustained by both participants, the whole character of Exercise Rhine had changed from an offensive endeavour to one of potential escape.

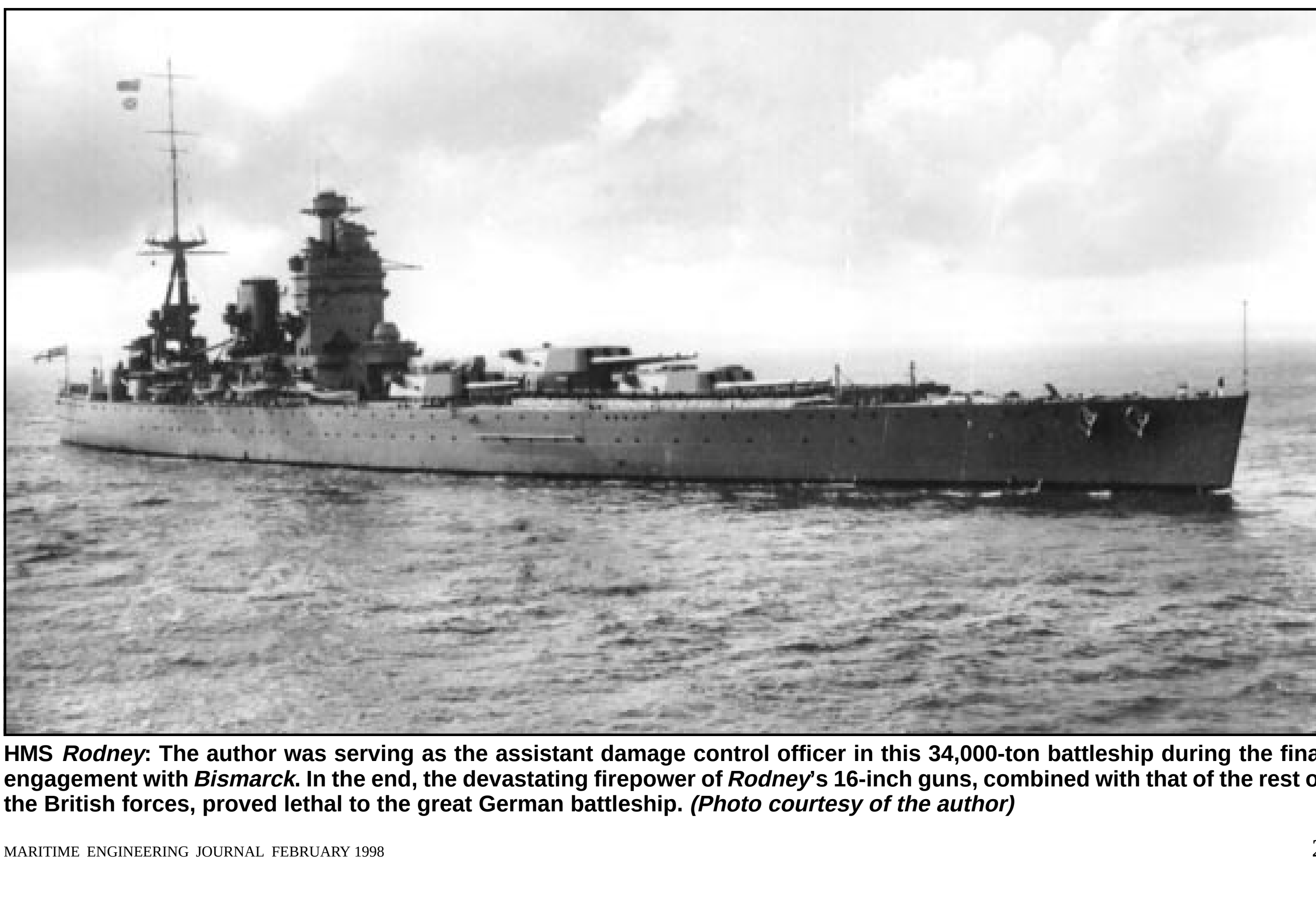
Throughout the 24th Lütjens continued south, making various unsuccessful attempts to break contact. Around this time the Admiralty began a series of redispositions, including having *Rodney* (in which I was embarked as the assistant damage control officer) break off from escorting *Britannic*.[3] Admiral Tovey, meanwhile, calculated that if *Bismarck* maintained her course and speed, the Home Fleet vessels could be in contact on the morning of May 25th. However, it was clearly desirable to try to slow the enemy down. The only option was an attack by *Victorious*' Swordfish aircraft which had a maximum target range of 100 miles. Thus, in spite of heavy weather, *Victorious* was ordered to head for *Bismarck*. The first torpedo attack (with quite new crews) took place around midnight on the 24/25th. Although bravely mounted (and with no losses), the attack was unsuccessful. *Bismarck* received only one torpedo hit on her armoured belt which caused little damage.

Early the next morning Lütjens noted that the British ships zigzagging off his port quarter briefly lost contact with his ship when on their eastward leg. At 0306, just after *Suffolk* turned onto her eastward leg, *Bismarck* immediately altered course to the west and finally managed to break contact before circling back around to a southeasterly heading for France. This should have given the Germans a certain amount of satisfaction (particularly as it was Adm. Lütjens' birthday), but in an address to the ship's company, he said:

> *The British are massing their forces to destroy us and we shall have another battle with them before we reach home. It may well be a question of victory or death. If we have to die, let us take with us as many of the enemy as we can.*

Somewhat prescient, perhaps, though not an accurate forecast and certainly not an oration to inspire confidence.

Now began a period demonstrating both operational and technical shortcomings. While heading southeast, Lütjens inexplicably began a series of lengthy radio communications. Listening stations



**HMS *Rodney*: The author was serving as the assistant damage control officer in this 34,000-ton battleship during the final engagement with *Bismarck*. In the end, the devastating firepower of *Rodney*'s 16-inch guns, combined with that of the rest of the British forces, proved lethal to the great German battleship. *(Photo courtesy of the author)***

in Britain recorded these, but had no decent cross-bearing to give an accurate indication of *Bismarck*'s position. Tovey had requested that he be advised of the *bearings*, not of their resolution, so that he could plot them in the flagship. Unfortunately, an error was made which resulted in a position being plotted appreciably north of *Bismarck*'s assumed track. All this led to some confusion and milling around of capital ships since it seemed, for a time at least, that the enemy was heading north rather than toward France. Late in the day after further messages from *Bismarck* had been plotted, all settled down so that *King George V* and *Rodney* (not yet in company) were following more than 100 miles astern.

During the night of May 25/26th the ships of both sides began having serious apprehensions over fuel — both British ships were low and *Bismarck*, now cruising at 20 knots, had just enough to reach Brest. But more significant events were afoot.

Early on the 26th a squadron of Catalinas from Coastal Command took off from Ireland in search of *Bismarck.* Thinking the German's course might be more southerly than the Admiralty had contemplated, Air Chief Marshal Bowhill (who had once been a seaman) added an extra area to the search. It was here at mid-morning that *Bismarck* was spotted.[4] Swordfish aircraft from *Ark Royal* (coming up from Gibraltar with Force H, and now between *Bismarck* and Brest) joined in shadowing the great ship. It soon became clear that unless *Bismarck* could be slowed down she would reach the cover of German land-based aircraft before the British could catch up. The weather continued to deteriorate with strong winds from the northwest.

The cruiser *Sheffield*, also from Force H, was ordered to close up and shadow *Bismarck* in preparation for an attack by *Ark Royal*'s aircraft. Unfortunately *Ark Royal* had not been advised of the cruiser's move, so the Swordfish enthusiastically prepared to attack the first large vessel (i.e. *Sheffield*) they encountered. Fortunately, *Sheffield*'s captain had experience in the target vessel role during Swordfish exercises. Recognizing an intended attack, he took violent and successful evasive action. (In a sense, this potential disaster had a technical benefit, for it demonstrated that the torpedoes' magnetic pistols were firing prematurely. They were replaced by contact pistols in a subsequent attack.)

The lack of success was reported to Adm. Tovey (wisely omitting comment on the *Sheffield* debacle) which produced considerable gloom. The overall situation was that *King George V* would have to break off at midnight due to lack of fuel, while *Rodney* (now in company) could only continue until 0800 the next day.

On the evening of the 26th, in worsening weather, *Ark Royal* launched her second attack. Heavy cloud prevented a co-ordinated approach, and initial reports were dismal. The attack had apparently failed. In *Rodney*, the captain broadcast, "*...we have lost our last chance of slowing down the enemy and bringing him to action."*

I must admit that at this news I felt much relieved. However, late on the night of 26th there came the astonishing (and, at first, unaccepted) report that *Bismarck* was heading northwest rather than southeast. After debriefing the aircraft crews, it now appeared that in addition to an inconsequential torpedo hit on the armoured belt amidships, a second torpedo had struck *Bismarck* on the starboard quarter. This was particularly significant. Not only had *Bismarck*'s steering gear compartment been breached and flooded, but the twin rudders were now jammed 15 degrees to port. (The hit was actually on the port quarter. If the torpedo had arrived about one second later, it would have missed the vessel altogether.)

This, then, was the key to the situation, for in the rough weather it proved impossible to get into the steering gear compartment or do anything to free the rudders. No combination of engine movements could offset the vessel's heading into the wind and, more or less directly, approaching the British capital ships. Adm. Tovey, not wishing to chance an action in bad weather and darkness, had the 4th Destroyer Flotilla maintain contact and harry *Bismarck* with (unsuccessful) torpedo attacks. And so action was contemplated for the morning of May 27th, some 400 miles from Brest. Our next dawn action stations would be the real thing.

The final morning arrived with blustery weather. By this time, *Norfolk* "in at the beginning" had arrived on the scene and, shortly before 0800, sighted *Bismarck* and relayed her position to *King George V* and *Rodney* coming up from the west in line abreast. *Rodney* opened fire at 0847, *King George V* at 0848 and *Bismarck* (firing on *Rodney*) at 0849. Down in *Rodney*'s damage control headquarters, we felt the frequent rumbles and shakes from the salvoes. For something to do I recorded the times of firing, and still have this scrap of paper.

While the German ship had only limited manoeuvrability, her armament was initially fully capable. As it turned out, a near miss off *Rodney*'s starboard bow was the only significant encounter. By this point the British ships were manoeuvring independently, with their range at times down to two miles. *Rodney*'s three forward turrets were depressed so severely that their blast caused numerous fractures and burst pipes along the main deck. All this, however, was trivial compared to *Bismarck*'s experience of having nearly 3,000 shells fired at her from the battleships and two cruisers, most of them being apparently directed at her forward bridge and superstructure.[5]

The armoured citadel remained essentially intact, but in the ensuing hour or so *Bismarck* absorbed a very great deal of damage. By 1000 she was essentially a floating wreck incapable of self-defence. We stood down and nipped up top to have a look at the distant burning hulk — by this time, all that was left of *Bismarck*. The fuel situation in the British battleships was critical by this time, and since nothing more could be achieved by gunfire we broke off the action to head for home. (Curiously, *Rodney* had submerged torpedo tubes and fired the full complement, considering that one might have hit.) Around 1030 *Dorsetshire* scored two torpedo hits on *Bismarck*'s starboard side and one against her port side, all from close range. Before this, however (probably from about 0930) a series of scuttling charges in *Bismarck* were fired on sea valves and condenser inlets. Likely it was the combination of these two actions that led to *Bismarck*'s rolling over to port and sinking at 1030.

An interesting technical note is that, sometime during the capsizing and sinking, the stern section abaft the steering gear compartment failed structurally and fell away. Photographic evidence of the wreck shows a ruptured transverse weld — probably due to the lack of notch toughness at the temperatures being experienced. As well, the longitudinal bulkheads providing structural continuity stopped forward of the fracture and, no doubt, the torpedo damage had not helped. After the ship capsized, the turrets and other debris fell away so that the wreck revolved again before eventually ending up more or less upright and horizontal at a depth of three miles (where it was subsequently photographed by modern-day undersea explorer Dr. Robert Ballard[6]).

**Conclusion**

In contemplating the lessons that might be learned from this major operation, there is perhaps not too much that is relevant for Canadian naval construction — and, indeed, possibly not too much that is relevant at all, since the era of battleships has passed. Nevertheless, we cannot but admire the effectiveness of naval construction that could withstand such a final battering. But, alas — to no avail. Here was this great vessel, still capable of massive fire-power and speed, brought to an end by an admittedly lucky hit near the rudders. We cannot but contemplate Benjamin Franklin's sage observation, "for the want of a nail, etc." This, perhaps, is the sort of problem that computer-aided naval construction is no doubt addressing — particularly in a time of precision-guided munitions.

All in all this encounter,[7] lasting more than a week and in which more than 4000 British and German lives were lost, was one in which *Bismarck* completely failed to address her main objective — attacking Allied convoys. But it did demonstrate superb technical achievement in a sea story covering an immense range of ocean — Baltic, Arctic, Atlantic and Bay of Biscay. In its own way, this foreshadowed the end of the battleship era, to which *Bismarck* was a memorable contributor.

**References**

1. Baron B. Von Mullenheim-Rechberg, *Battleship Bismarck — A Survivor's Story*, Naval Institute Press, 1980 (pp. 75-76).

2. *Bismarck* had already passed through the canal en route from Hamburg to Gotenhafen.

3. Mullenheim-Rechberg notes (p. 138) "Within six hours of the loss of the *Hood*, the British had deployed against us 4 battleships, 2 battle cruisers, two aircraft carriers, three heavy cruisers, ten light cruisers and twenty one destroyers. And so there began a chase which, in terms of the area involved (more than a million square nautical miles) and the number and strength of the ships engaged, is perhaps unique in naval history."

4. This aircraft Z/209 was, at the time, being piloted by an American ensign secretly on loan to the RAF because of earlier experience in Catalinas.

5. W.H. Garzke Jr. and R.0. Dulin Jr., *The Bismarck Encounter,* Chesapeake Section of the Society of Naval Architects and Marine Engineers, June 5, 1991.

6. R.D. Ballard, *The Discovery of the Bismarck*, Madison Press, 1990. A fascinating account of the search for the sunken *Bismarck* with underwater photographs taken at a depth of about three miles.

7. In this author's view, the most comprehensive account of the battle is L. Kennedy's, *Pursuit — The Chase & Sinking of the Bismarck,* Collins, London, 1974.

*RAdm Davis is a professor with the School of Policy Studies at Queen's University in Kingston.*

# Book Reviews

## Submarine Technology for the 21st Century

Reviewed by Lt(N) Erick DeOliveira

*"Submarine Technology for the 21st Century, 2nd Ed.," Stan Zimmerman, Pasha Publications Inc., 1997, illustrated, indexed, 219 pages, ISBN 0-935453-83-0.*

"Ace submarine skippers contribute far out of proportion to their numbers...," begins *Submarine Technology for the 21st Century.* After the author observes that even the best WWII submarine commanders were thwarted by ineffectual torpedo warheads, he presents the corollary that advanced propulsion, weapon and $C^4I$ systems will amplify the submarine threat many times and further inflate the submarine's disproportionate influence in the ocean theatre.

Stan Zimmerman, a former editor of *Navy News & Undersea Technology*, addresses how scientific and engineering breakthroughs are affecting submarine design and operations, and considers the impact made by an increasing number of nations which are acquiring submarines with capabilities that threaten the superiority of the SSN.

One of the book's strengths is how the author succeeds in lifting the veil of mystery from the nuclear and AIP propulsion technologies. Before discussing each in turn, Zimmerman separates individual nuclear and AIP designs as clearly as combustion engines are separated into diesel, steam, and gas turbine designs. Of particular interest to the Canadian naval community is the attention paid to the AMPS low-power nuclear plant (a former contender in the submarine power market) and the discussion surrounding the currently-favoured Ballard Power Systems fuel cell.

The formidable combination of new weapons and new propulsion technologies is also explored. The French sale of three hulls to Pakistan with sub-Exocet and an AIP option (the French MESMA technology) is offered as an example of how very powerful and flexible weapon systems are becoming available to many nations. Future weapon systems are also reviewed, such as the Russian 200-knot "Squall" anti-torpedo torpedo, and the conceptual British "Magnum" modularized weapon delivery system that attaches to a submarine's pressure hull. The book also looks at state-of-the-art developments in sensors and data fusion, countermeasures and communications.

*Submarine Technology for the 21st Century* is a comprehensive review of submarine technical issues that is very readable and avoids being an academic treatise. The author has included an index and a helpful glossary of acronyms which will be useful for newcomers to the subject. In addition, an appendix lists 29 WWW sites (governmental, non-governmental, commercial and private) that are excellent starting points for those who wish to explore the subject further.

The engineer who must manage and maintain shipboard systems, and the surface warfare officer who must operate against these advanced threats, will find this a valuable book.

*Lt(N) DeOliveira is the DMSS 5-6 project manager for air-independent power, and has published original research on the behaviour of fuel cells in future submarine systems.*

# No Day Long Enough — Canadian Science in World War II

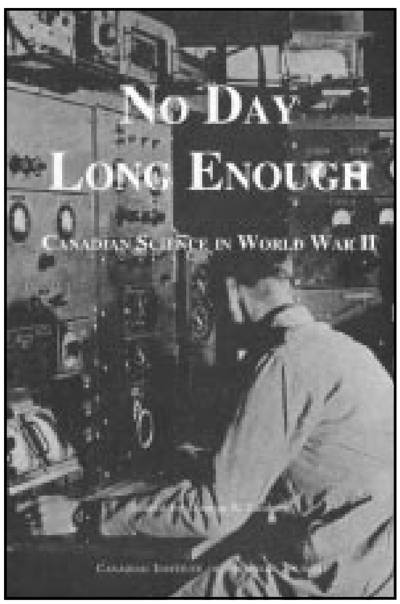
Reviewed by Simon Igici

*"No Day Long Enough — Canadian Science in World War II," George R. Lindsey, ed., Canadian Institute of Strategic Studies, Toronto, 274 pages, illustrated, paper, ISBN 0-919769-65-9*

A recent release from the Canadian Institute of Strategic Studies, *No Day Long Enough* is a collection of stories written mainly by the scientists and engineers who were directly part of Canada's engineering and scientific effort during World War II. The book provides a very good overview of the Canadian scientific contribution during a period which saw rapid technological advances.

As the title suggests, Canadian scientists worked flat out to solve the pressing technological challenges of the day, covering everything from medicine and nuclear physics, to radar and anti-submarine warfare. In many cases, developments conceived in Britain and the United States were tested first in Canada.

One such trial involved HMCS *Edmundston* and an unusual idea for rendering ships less visible to submarines at night by *illuminating* them to match the lighter background of the nighttime sky. With its special lighting system switched on, *Edmundston* was able to approach unseen to within 300 yards of a Royal Navy submarine, even though an accompanying control vessel was easily visible at more than twice that distance.




*When the submarine commander asked for "lights off", the* Edmonston *(sic) leaped into view....When the commander requested "lights on", the* Edmonston *again disappeared, and could not be found, even though they knew exactly where to look for her!*

The key theme that emerges from these stories and recollections is the significant war-time role played by the National Research Council (NRC) in the rapid establishment of scientific, technical and manufacturing capability in Canada. The breadth and depth of NRC's leadership in coordinating the scientific efforts of Canadian industry, universities and Crown corporations during the relatively short time frame of the war is astonishing.

The stories also highlight the long-term benefits of scientific breakthroughs achieved during the war, such as the use of heavy water in today's nuclear reactors. An important lesson that one draws from this book is the invaluable long-term strategic benefit provided to Canada by sustained R&D, under good leadership and sound vision.

*No Day Long Enough* is a good eye opener for those who are not familiar with the Canadian scientific contribution to the allied war effort in World War II. It is also a good source of reference for those who wish to learn further about the subject.

*Simon Igici is a project engineer with DMSS 7 in Ottawa. He has been a combat systems technical editor for the* Maritime Engineering Journal *since 1994.*

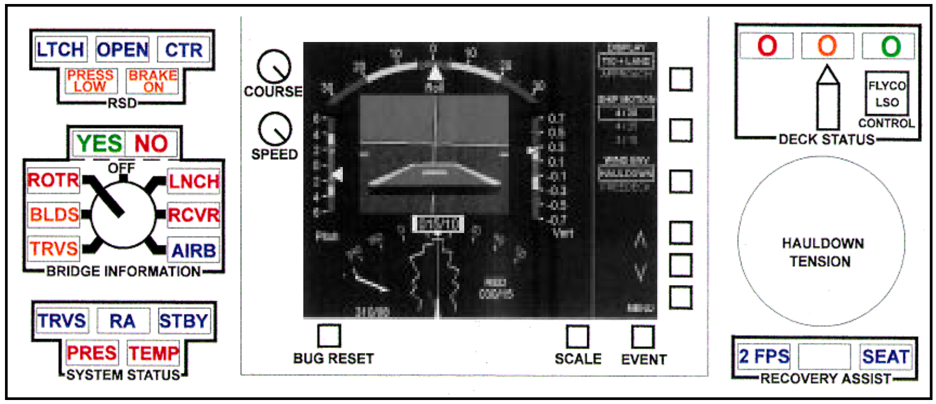
# DGMEPM News Round-up

## *Human Factors Engineering: LSO compartment study*

Canadian Marconi Company Ltd. recently completed a study aimed at improving human-machine integration of landing safety officer (LSO) compartments on *Halifax*-class frigates and *Iroquois*-class destroyers. The study addressed two main issues — improving LSO external visibility, and improving visual access to information provided by diverse independent indicators.

The study included an analysis of the LSO's tasks, preparation of a three-dimensional CAD model of the *Halifax*-class LSO compartment and flight-deck area, design of an integrated display for the presentation of all required information, and rapid prototyping of the display formats. This work was followed by development and evaluation of the 3-D model of the proposed arrangement, using an anthropometrically variable man modelling program (SAMMIE®), an evaluation of the integrated display format prototypes by end-user "subject matter experts," and design, construction and evaluation of a full-scale mock-up of the proposed modified LSO compartment, along with a second partial mock-up to assess access and egress arrangements.

In co-operation with the Defence and Civil Institute of Environmental Medicine (DCIEM) in Toronto, a helmet-mounted virtual reality simulator was used by experienced LSOs to assess the external field of view. The simulation included an independently controlled virtual helicopter and featured actual flight-deck motion data (provided by Defence Research Establishment Atlantic) to visually simulate the motion environment. The effect was very compelling, as verified by attendees to the NDHQ 97 stand-up event held at Cartier Square Drill Hall in Ottawa last September. The mock-up and VR simulator were a hit of the show.




**This proposed RAST console incorporating an integrated display received strong endorsement from operators. An exploratory development model of the display underwent operational evaluation on board HMCS *Charlottetown* last May. *(Images courtesy of Canadian Marconi Ltd.)***

The motion data also greatly aided development and evaluation of an exploratory development model (XDM) of the integrated display which includes roll, pitch and vertical acceleration data (as well as wind speed and direction, and ship course and speed). Following expert evaluation of the XDM at DCIEM, an operational evaluation was conducted on board HMCS *Charlottetown* in May 1997. Although some minor glitches arose, the XDM was over all favourably received. The evaluation achieved improved performance in terms of permitting LSOs to complete tasks in less time, with greater accuracy and fewer errors.

The project, which ran from March 1996 to December 1997, concluded with a series of detailed reports making specific recommendations for improving human-machine integration of LSO compartments. — **James Menard, DMSS 2-6, project manager.**

# News Briefs

## *CANTASS*

The last shipboard installation of the Canadian Towed Array Sonar System (CANTASS) was successfully completed on board HMCS *Ottawa* in the summer of 1997. The project management office for CANTASS continues to fund enhancements to the deployed CANTASS and will release Baseline III (CCS interface and MMI issues) later this year.

Two portable shipboard CANTASS simulators have also been procured to enhance training proficiency in deployed ships as well as provide Sea Training staff with a valuable assessment tool. The High Fidelity Tactical Acoustic Sonar Simulator (HITASS) will allow a CANTASS mission to be created and run on any shipboard CANTASS. This capability will greatly enhance the operational effectiveness of ships' CANTASS teams, and partially address the current lack of "in contact" time.

The PMO's main focus has shifted to the procurement and delivery of the CANTASS Mission Simulator (CMS), a COTS-based training simulator that allows up to four separate missions to be run simultaneously on four workstations that replicate a shipboard CANTASS. The shore-based simulator will provide a realistic environment for conducting team and individual operator proficiency training. CMS completed formal testing of the last software module in early March. System integration and performance will be validated during factory acceptance testing scheduled for May. It is expected that the CMS will be installed at the Canadian Forces Naval Operations School (CFNOS) by December, by which time the initial training of instructors and maintainers should have been completed. CFNOS anticipates conducting initial coursing on the system in early 1999. **— LCdr Sean Midwood, DMSS 7-8, PM CANTASS.**

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