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Maritime Engineering Journal

CNTHA News Inside

CANADA'S NAVAL TECHNICAL FORUM — Summer 2006

Replenishment at Sea —

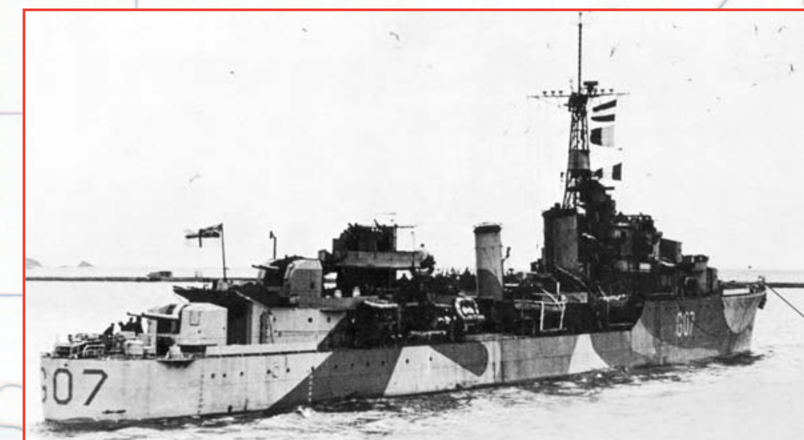
The Navy's First Steps with "One-stop Shopping"

Also in this Issue:

- **Women in Defence and Security**
- **Recertifying Submarine HP Cylinders In Situ**
- **Exploring the Wartime Wreck of HMCS *Athabaskan***

Canada

What sank HMCS *Athabaskan* in the English Channel in 1944?



Athabaskan image courtesy DND Directorate of History and Heritage

...and does the ship's missing stern section hold the answer?

— Story inside

Maritime Engineering Journal

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(Established 1982)

Director General
Maritime Equipment Program Management
Commodore Richard W. Greenwood, CD

The *Journal* is available on the DGMEPM website located on the DND DIN intranet at http://admmat.dwan.dnd.ca/dgmepm/dgmepm/publications

DEPARTMENTS

FEATURES

Cover Photo: Military historian Dr. Ken Reynolds tells the story of the navy's introduction to replenishment at sea. *(DND photos)*: HMCS *Yukon* refuels from HMCS *Provider*. *(Inset)* HMCS *Cape Breton* at sea in 1953. Article begins on page 5.

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Commodore's Corner

Crunch time for naval technical training

By Commodore Richard Greenwood, CD
Director General Maritime Equipment Program Management

The MARE Council, the naval technical community's senior advisory body, meets twice a year to examine issues, priorities and actions affecting officers of the MARE career field and the NCM (non-commissioned) naval technical occupations. If there is one item pushing itself to the forefront of the Council's discussions these days, it is the burning issue of how the navy expects to meet its personnel training requirements (and even what those requirements should be) during the upcoming *Halifax*-class modernization project.

The frigate modernization project poses serious challenges on a number of fronts, not the least of which is the impact a reduction in the number of available seagoing training billets will have on personnel training and career advancement. Beginning around 2010 and continuing through 2016, as many as five out of the 12 ships in the fleet of *Halifax*-class patrol frigates could be expected to be out of service at any one time for midlife refit and modernization. The challenge of managing even a temporary loss of sea billets for six years is formidable enough given our current personnel numbers, but the navy is aggressively recruiting additional naval technical officers to make up for current shortfalls. It doesn't take a mathematician to figure out that both the premium and demand for bunk space will increase dramatically. This issue will have a direct impact on the availability of shipboard billets for naval technical officers and NCMs alike, as well as for personnel in the other seagoing trades.

So where do we stand with this? As you can imagine, the MARE Council is working very closely with the other concerned naval advisory groups to find a workable solution. Until now we have depended on a well-established training process that includes prescribed amounts of sea experience to deliver the knowledge and develop the skill sets we require of our technical personnel. I don't think anyone would disagree that, as a result, the Canadian navy enjoys a world-class talent in its technical officers and NCMs. The question we have to consider now is, Have our requirements changed? The quality of our naval technical training has certainly left us well positioned for the challenges of today and the near future, but what about for the longer term? It takes years to develop our officers and NCMs to the standard we currently demand, yet we are facing a serious shake-up to the training status quo with the upcoming *Halifax*-class modernization project.

It doesn't take a mathematician to figure out that the premium for bunk space will increase dramatically.

The situation right now is anything but clear. The implementation of the project itself and the resulting impact on ship schedules have yet to be fully defined, and we also have to look beyond the frigates to their eventual single-class replacement and consider the implications and options for how we train our people. If history is any indication, we can almost certainly expect that a new generation of ships will bring some fundamental changes, and that by the time the smoke clears from the frigate modernization program in 2016 we will be on track with a much different long-term training and career vision.

The complicated issue of possibly realigning the navy's technical training and career employment to meet future requirements is on the front burner at all levels of the navy right now. The goal, of course, is to devise a 100-percent solution that meets the needs of the fleet and the career aspirations of the navy's personnel. Is this achievable? We think so. Constructive compromise will be the order of the day as we take a fresh look at our requirements and reposition ourselves for what promises to be a new era in naval technical training. Making up for the anticipated loss of platform availability for at-sea training opportunities will call for creative workarounds, to be sure, and it is very likely that any solution will include greater reliance on simulator-based training.

It's a tough nut we have to crack, sorting this out, but the possibilities for the future of naval technical training and employment are excit-

Photo: Brian McCullough

The MARE Council's primary responsibility is to provide advice on issues, priorities and actions affecting officers of the MARE career field and NCM naval technical occupations. The Council most recently met in Halifax in late March around the time of the MARLANT Technical Support Seminar, and will meet again in Victoria this October to coincide with the West Coast MARE Seminar. Minutes of all MARE Council meetings are available on the DGMEPM website. From left to right, the Council includes: Capt(N) Eric Bramwell, Capt(N) Martin Adamson, Capt(N) Gilles Hainse, Cdr Richard Gravel, Capt(N) Mike Williamson, Cmdre Richard Greenwood, Capt(N) Jim Jollymore, Capt(N) Richard Payne, Capt(N) Richard Houseman, CPO1 Jean-Marc Turcot (DGMEPM Unit Chief), and Capt(N) Pat Finn. Unavailable for the photo were RAdm Ian Mack, Cmdre Jim Sylvester, Capt(N) Alex Rueben, Capt(N) Mark Eldridge, Capt(N) Andy Smith and Cdr Wayne Rockwell (Secretary).

ing. As we wrestle with these issues over the next several years, the one thing we can rely on is the ability and willingness of the naval technical community to adapt to any change and to provide the necessary leadership at all levels to ensure we don't lose anyone along the way. It is something we do very well, providing systems solutions for the navy, always remembering that a system comprises much more than just the equipment. It also includes the operator/maintainers.

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.

Forum

CPO1 Denis Chitouras — A Story of Success and Inspiration

Last October I had the good fortune to attend Chief Petty Officer 1st Class Denis Chitouras's retirement function at the Chiefs & Petty Officers Mess in Ottawa. I planned to just wish him farewell and good luck, and enjoy a quick pint. After all, he wasn't going far. He was trading his uniform for an EG-06 position within DGMEPM.

I had no intention of speaking. I was just going to sit back and listen to what others had to say, and remember some of the experiences I had shared with Denis. As the speeches and accolades came to an end, however, I realized that the speakers had covered only the last few years of Denis's career — the "twilight years" he spent at NDHQ in the career shop and in DGMEPM. No one really mentioned his time in Halifax, or, more importantly, his time at sea in submarines. I knew I couldn't sit idle. His story needed to be told, so I got up and "spun the dit."

CPO1 Chitouras's career is truly one of success and inspiration. I first met him in the mid-80s when he was a PO2, Cert 2C, and I was joining submarines as a Part 3 trainee. I was doing my submarine and head of department training on board HMCS *Onondaga* and Denis was one of three engineering officers of the watch. Not only was he a P2 Cert 2, but he had ceased training, something that was allowed back then for those who were happy to remain in their current rank and job. This policy changed a few years later, forcing Denis back into the training pipeline to get his Cert 3C. Unfortunately, his training didn't go as quickly as it should have and he was confronted with being released for lack of progress. At the brink, Denis had to make the decision to commit to getting his qualification. He worked hard, achieved his Cert 3C, and never looked back. He was on a roll.

Denis went on to get his Cert 4, and was promoted CPO2 and appointed Chief ERA in HMCS *Ojibwa*. By this time I was the submarine squadron technical officer, and I worked closely with Denis and his engineer officer as they took *Ojibwa* out of refit and through the demanding rigour of sea trials, ramping the boat up to high readiness. Many was the time we found ourselves on the submarine jetty at some ungodly hour in the morning fixing defects to maintain the boat's program. I was watching a now confident, highly motivated and inspirational CERA performing like never before.

Photo: Brian McCullough

CPO1 Denis Chitouras

It was well known throughout the fleet that Denis was a competent stoker, but not the most adept at swinging a spanner. He may not always have been the first person to be picked when a critical job required some intricate dismantling and repair of marine systems equipment, but now as the senior NCM in the department that didn't matter. Denis knew his role cold. As CERA it was his responsibility through the engineer to ensure the technical readiness of the engineering department. It was a responsibility he took seriously, and he was smart enough to realize that the boat's technical readiness was directly linked to the readiness and capabilities of his men. First and foremost, he looked after the well-being of his people. The rest fell into place simply because he took care of his men and provided them with strong leadership. It was a pleasure to watch him instill in his subordinates the confidence, trust and motivation necessary to ensure the submarine was operating at its peak. His solid leadership was directly responsible for the profound impact the engineering department had in the successes enjoyed by *Ojibwa* throughout his service on board.

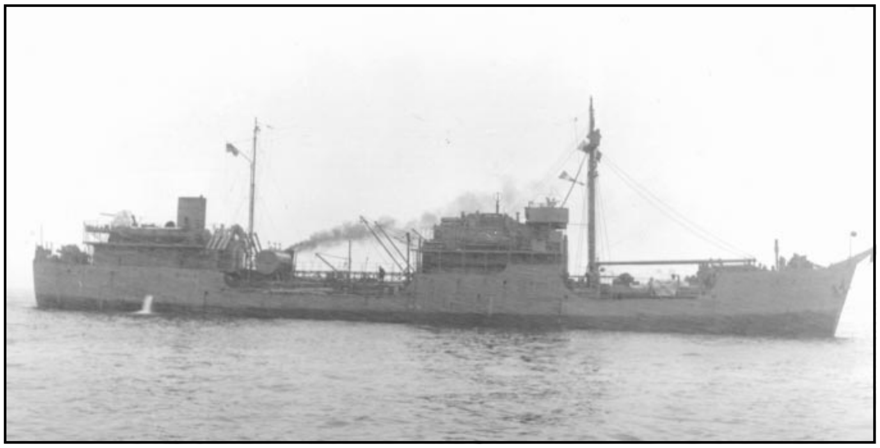
As I spun this tale at his going away, I regretted there were no junior NCMs there to hear his inspiring success story. Having gone from a petty officer 2nd class who had ceased training and had little ambition for moving up, to a chief petty officer 1st class in such a relatively short period of time was a tremendous feat. It required hard work, determination, guts and strong leadership — character traits that speak to the core of what and who Denis Chitouras is. He served Canada proud as a sailor, and I am sure he will continue to do so as a public servant.

Bravo Zulu, Denis, and all the best. **— Cdr Marcel Hallé, DMEPM – SM 5, Submarine Class Desk**

One-stop Shopping — Replenishment at Sea and the Royal Canadian Navy, 1945 to 1961*

Article by Dr. Ken Reynolds

When she left Canadian waters for the last time in 2002, the former HMCS *Provider* (AOR-508) sailed a quarter of the way around the world to work as a supply barge in the Greek islands. Commissioned into the Royal Canadian Navy in September 1963, *Provider* (the second ship of that name) was the first of her kind for this country, the "one-stop shop" replenishment at sea vessel, older sister to Her Majesty's Canadian ships *Protecteur* (AOR-509) and *Preserver* (AOR-510). How the RCN ended up with such a ship, such a series of ships, is a fascinating story with roots going back some 60 years.



Early days: the first HMCS *Provider*. *(All photos courtesy DND)*

Underway Replenishment — the Early Days

Underway replenishment is an activity that the United States Navy perfected during the Second World War. Before 1944 the only replenishment at sea the Americans typically carried out involved oilers refuelling ships at sea. Warships came to port to be resupplied. As the Pacific campaign progressed, however, task groups stayed at sea longer and used more ammunition and supplies than ever before. Oilers started to carry extra items and, in late 1944, the Americans formed a logistics support group incorporating ammunition and stores ships to conduct replenishment at sea. This "fleet train" allowed the task groups to be replenished at sea in a fraction of the time it had previously taken.

Nothing else compared to the American organization. The Royal Navy relied mainly on shore stations for replenishment, and what refuelling at sea it did conduct in the North Atlantic and in the Russian convoys reflected cumbersome procedures developed long before the war. It was only when they joined the USN in the Pacific that the British began to take a comprehensive look at the matter. The truth was, an American-style fleet train was a very expensive proposition and was only partially adopted by the British.

For the Royal Canadian Navy, replenishment at sea during the war closely followed the doctrine and practice of the British. Canadian warships spent most of the war struggling with the difficult astern method of refuelling from tankers and oilers. The cruiser HMCS *Uganda* did experience the American method of alongside replenishment while in the Pacific, but one warship late in the war did not effect any change in Canadian policy.

Canadian Observations and Practice after 1945

Underway replenishment continued to be a topic of interest for the American and British navies immediately following the war, and the RCN kept watch on developments. In late 1947 Canadian naval staff reported on recent British replenishment trials carried out by HMS *Bulawayo*, a former German U-boat fuel and supply ship. Although most of the trials involved refuelling at sea, experiments in transferring stores and ammunition were also conducted. The RCN also sent Commander (S) Charles Dillon and other officers south in 1947 to observe the American mobile replenishment set-up with the U.S. Atlantic Fleet. Dillon informed the Naval Board of his experience and the benefits the

[*This article is an abridged and edited version of a paper of the same name presented by the author at the 7th Maritime Command Historical Seminar in Ottawa on September 23, 2005. The full, referenced version containing a more complete account of the navy's investigation into a nuclear propulsion option for fleet replenishment ships will be found in the proceedings of the Maritime Command Historical Seminar when they are published.]

RCN would receive if it acquired similar logistics vessels, but Canadian developments in underway replenishment were caught up in the postwar downsizing and were slow to materialize. Two former Fairmile motor-launch depot ships, HMCS *Provider (1st)* and her sister, HMCS *Preserver (1st)*, were even paid off in 1945 and 1946.

Doctrinally, it was apparent that Canada would follow the lead of the Americans and British. After all, Canadian warships would be operating with their warships on exercise or in a war and would need to use their oilers to refuel. At the same time it was decided that Canadian warships should continue to practise passing stores, ammunition and personnel from ship to ship whenever possible. This line of thinking was typified in 1948 when a request to have the auxiliary oiler *Dundalk* modified to refuel warships at sea (at the grand cost of $692) was declined. It was argued that it would be more beneficial for Canadian warships to practise refuelling at sea with one another. *Dundalk* and her sister ship *Dundurn*, it was noted, were coastal tankers not meant for use in the open sea.

By the end of 1950 the office of the Director of Weapons and Tactics had produced draft staff requirements for fast fleet oilers for the RCN. Capable of keeping up with the fleet at 20 knots these ships would support the fleet during long periods at sea by refuelling four ships simultaneously — one ship on each side and two astern. The response from Naval Constructor-in-Chief Captain Rowland Baker in March 1951 noted this would require a large vessel costing $10 million to build in Canada. The navy was not considering acquiring such ships, but was instead resolving the requirements for using commercial tankers in an emergency.

During the Korean War, Canadian warships were primarily supported by American and British base facilities and supply organizations. As a senior naval officer acknowledged some years later, although this allowed the RCN ships to remain on station at sea, it made the fleet particularly dependent on the Americans for its logistical support.

The Canadian Forces Auxiliary Vessel (coastal tanker) *Dundalk*

Meanwhile, the American and British navies continued their examination of former German replenishment vessels. The Americans had received the ex-German *Dithmarschen*, sister ship to HMS *Bulawayo* (ex-*Nordmark*), and commissioned her into the USN in 1953 as the USS *Conecuh*. She was eventually designated AOR-110 (auxiliary oiler, replenishment), the first ship to receive that prefix, and served as a replenishment fleet tanker in the Atlantic and Mediterranean until 1956. It is quite clear that this ship helped pave the way for the development of the American AORs and the AOE fast combat support ships.

British trials continued with HMS *Bulawayo* until 1955. The lessons learned from her were built into the British Tide-class fleet oilers, the first of that class being launched in 1954. Canada was given an opportunity in 1953 to purchase one of the Tide-class vessels under construction, but decided to decline the offer as construction of a tanker in Canada would better suit the long-term interests of the RCN.

NATO and the RCN's Progression Toward RAS

The American and British navies followed the concept of replenishment at sea in their own ways, and each had an influence on the route the RCN ultimately followed. So too, ironically, did the wartime German navy. The smaller, geographically dispersed, and resource-challenged RCN had much in common logistically with the *Kriegsmarine*. All of these influences would make their mark in two separate, yet interconnected paths of thinking and development in the RCN in the 1950s and 1960s. The first path followed the development of a mobile logistics program for the navy, especially as it tied into the needs of the North Atlantic Treaty Organization. The second path involved converting existing vessels to help meet the fleet's logistical needs.

At the end of September 1955 the navy's Director of Naval Plans and Operations, Captain William Landymore, noted that with the growing size of the navy and more frequent NATO exercises Canadian warships would need to refuel from British or American tankers. The role of the RCN in NATO was having an increasing impact on Canadian naval planning. In May 1956 the Naval Board reviewed the navy's mobilization plans in light of NATO's MC 48 strategic guidance policy which recognized the Atlantic Ocean as both NATO's "defensive depth" and its avenue for reinforcing land forces in Europe. During that meeting, Constructor Captain Baker announced he had prepared a design for a 10,000-ton, 20-knot fleet replenishment vessel "to provide mobile logistics support to the fleet." The ship was capable of carrying fuel oil, aviation fuel, stores and up to 12 helicopters. In a pattern that continued to recent years, he recommended two tankers for the Atlantic coast and one for the Pacific.

At the end of May the Naval Board discussed the draft preliminary naval estimates for the next fiscal year (1957-58), which called for a design study to be initiated on a "tanker/maintenance ship." Vice-admiral Harry DeWolf, Chief of the Naval Staff, questioned the proposal, finding it "difficult to envisage a ship that could carry out all the intended functions." DeWolf's vice-chief, Rear-admiral Horatio Lay, responded to the contrary by noting that preliminary staff studies indicated that it was indeed a feasible proposition. Further study followed, and at the end of July Captain Landymore submitted draft staff requirements for a tanker/maintenance ship similar to that proposed in May.

Tanker/Supply Ships — Round 1, 1957

The seed had been planted, but the project would still take more than two years to be fleshed out and obtain the necessary approvals. In April 1957 Captain Robert Murdoch, Director of Tactics and Staff Duties, signed off on the latest draft staff requirements for a tanker/supply ship. The ship would have to be able to operate in arctic and tropical conditions and would be equipped with sonar, but it would have no gun or missile armament. Countermeasures would be limited to torpedo defence. In May the Naval Staff recommended to the Naval Board that the construction of three tanker/supply ships be made an "A" level priority in the naval estimates for 1958-59.

The pressure to procure these vessels was maintained by Captain Landymore in July 1957 in a report on underway replenishment. Noting that all modern warships were equipped to be replenished at sea, he saw this activity as the means "to sustain the highest possible intensity of operations in war" for the Canadian fleet. He estimated that during active operations five or six Canadian anti-submarine warships would be away for refuelling and resupply at a fixed base at any one time. Either more escorts needed to be built, or the fleet needed to be resupplied on station. He recommended the latter through the purchase of three Canadian-built replenishment vessels in the 15-to-22-knot range, capable of carrying fuel and provisions.

The Royal Fleet Auxiliary vessel *Tidepool*

The Naval Staff approved Landymore's proposal one month later, passing it on to the Policy and Projects Co-ordinating Committee (PPCC) which agreed that three tanker/supply ships should be made an "A" level priority for the navy. In October the Naval Board examined the proposal in the context of ensuring the most effective use of Canadian warships in the initial phase of a war. The board wanted more information on such things as the size and displacement of the ship, its proposed uses in peacetime, and whether it would be crewed by the navy or by civilians. Until such information was provided, the Naval Board would defer a final decision.

It is of interest to note that during this period the Naval Staff also discussed the possibility of providing the new supply ships with nuclear propulsion. By April of 1958, however, this idea was shelved due to the estimated cost of $20 million per ship, and the navy's own change in priorities which now focused on placing nuclear propulsion within Canadian-built submarines.

The Cape-class Ships, 1950-1957

While the process to get three tanker/supply ships approved continued, other developments of note were taking place within the RCN. In 1951 two escort maintenance vessels built in Canada during the war for the Royal Navy were returned home. *Beachy Head* and *Flamborough Head* each measured 442 feet in length, displaced about 10,000 tons and had a speed of 10 knots. Each was equipped with workshops and able to maintain one to two dozen escort warships away from shore support.

Initially the plan was to refit both ships as maintenance or headquarters vessels, but a lack of trained technical trades personnel in the navy led to the use of *Flamborough Head* as an apprentice training facility, providing both classrooms and accommodations for instructors and students. Modifications complete, the ship was commissioned into the RCN as HMCS *Cape Breton* (hull pennant 100) in 1953. Moored alongside the Halifax dockyard, this "floating schoolhouse" trained about 300 naval technical apprentices over the next five years. *Beachy Head*, meanwhile, was renamed *Cape Scott* (101) but was not commissioned. She also participated in the training program by dealing with overflow from *Cape Breton.*

By the end of 1954 questions had been raised about the desire to modify the Cape ships as escort maintenance vessels. It was argued that proper maintenance and repair of the Canadian fleet would require a repair ship displacing 25,000 to 30,000 tons — up to three times the size of the Cape ships. After more than a year of silence on the matter, the first draft staff requirements for an escort maintenance ship were issued in March 1956. Details were sketchy, but the document fuelled debate as to whether the Cape ships were up to the task. The draft document outlined a ship with an endurance of 15,000 miles at 15 to 17 knots, armed with four 3-inch guns and defensive measures, and fitted with extensive workshops and storage facilities. Over the next 14 months debate within naval headquarters led to calls for many significant additions to the capabilities and, in particular, to the structure of the proposed vessels. One suggestion even called for one of the Cape ships to be modified as a one-stop supply ship to carry provisions, refrigerated goods, general stores and, possibly, armament stores.

Captain Murdoch brought the discussion back under control. In May 1957 he noted that although the navy seemed to want a ship of "far greater dimensions" than a Cape-class vessel, that option was "most unlikely." The Cape ships would have to do. He submitted another draft of staff requirements for the proposed escort maintenance ships, which in addition to their primary duties also called for these vessels to provide "limited logistic support" to escorts away from port. The Cape ships would be modified to operate in arctic and tropical conditions, strengthened for navigation in ice, and outfitted to operate two helicopters. The ships would remain unarmed. The Naval Board gave its approval for this plan on Nov. 27, 1957.

HMCS *Cape Breton*

Tanker/Supply Ships — Round 2, 1957-1958

By the late winter of 1957-58 the senior naval leadership was ready to recommend the construction of the tanker/supply ships to the Chiefs of Staff Committee in the hope of receiving its approval to forward the request to the federal government. On Feb. 21, 1958 VAdm DeWolf signed the navy's proposal, maintaining it was in line with the needs of NATO's military policy that the Atlantic be defended as far forward as possible. The tanker/supply ships would form part of the navy's overarching logistics support program along with shore infrastructure and fleet repair abilities.

In terms of procurement, the navy had looked at chartering or requisitioning commercial tankers, but determined this would not meet the navy's needs. Purchasing or renting existing naval vessels had also been considered. Ten existing foreign designs were examined, including the British Tide class, which most closely met Canadians requirements, but these ships might no longer be available. Instead, VAdm DeWolf proposed that the tanker/supply ships be built in Canadian shipyards at an estimated cost of $15 million each, with construction starting in 1959.

The Chiefs of Staff Committee reviewed the RCN's submission on June 10, 1958 and after some discussion agreed to the navy's proposal. The Minister of National Defence would be asked to recommend to the Cabinet Defence Committee that construction of the tanker/supply ships begin in 1959-60.

A few days before the Chiefs of Staff met, Captain John Charles, Director of Naval Plans and Operations, expanded the overall debate within the navy concerning what types of logistics vessels were necessary. He proposed the navy acquire a "fleet issue ship" for each coast to supplement the ability of the tanker/supply ships to provide ammunition and stores to the fleet through replenishment at sea. He realized such "mobile supply depots" would be expensive to build and recommended acquiring two Canadian National Steamships cargo ships. The PPCC reviewed this proposal, but felt that in view of the decision to pursue construction of the tanker/supply ships, fleet issue ships would be of marginal use.

The Naval Board examined the latest, largely unchanged, draft staff requirements for the tanker/supply ship on July 17, 1958. The ship was to provide replenishment at sea with respect mostly to fuel, but also to stores, ammunition and replacement helicopters. The vessel needed to sail at 20 knots, have a range of 5,000 miles, have a deep displacement of not more than 22,000 tons, and incorporate a crew of 12 officers and 124 sailors. The board accepted this latest draft.

In September 1958 The Honourable George R. Pearkes, Minister of

National Defence, duly made his submission to the Cabinet Defence Committee. Noting that the lack of Canadian mobile logistical support undermined Canada's naval contribution to NATO, he supported the navy's request to construct three tanker/supply vessels in Canada. The minister called for the construction of the first ship to begin in 1959-60, with completion expected in 1962-63. Cabinet agreed on Nov. 12, 1958.

Cape-class Ships, 1958-1960

After several years of debate the Cape ships were finally to be modified as escort maintenance vessels. The apprentice training program on board HMCS *Cape Breton* was closed down, and in the summer of 1958 the ship relocated to Esquimalt and was paid off. The conversion took more than a year to complete and included the installation of additional workshops and a helicopter landing platform. She was recommissioned in November 1959 and took up her post in Esquimalt in March 1960. HMCS *Cape Scott*, which had never been brought into full service in the RCN, was converted more quickly and commissioned in January 1959 with a complement of 270 officers and men operating out of Halifax.

Both ships carried out their escort maintenance and repair duties, and at the same time began to provide limited logistical support by performing replenishment operations of interest to the larger pursuit of underway replenishment within the RCN. Of note are a refuelling at sea exercise carried out by *Cape Scott* in December 1959, *Cape Breton*'s work as a headquarters ship during WINTEX 61, and the 1960-61 investigations into using both ships for sealifting Canadian army troops, vehicles and material.

Tanker/Supply Ships — Round 3, 1958-1960

The Naval Board was informed in December 1958 that the design drawings for the tanker/supply ship would be delivered to the Department of Defence Production in January 1959. DDP would be responsible for contracting out the ship's construction, which the board hoped would take place as soon as possible.

On the very same day that the Naval Board was being briefed, Commodore Angus Boulton, the Assistant Chief of the Naval Staff (Plans), proposed that the possibility of acquiring fleet issue ships be re-examined in the interests of mobile logistical support. To make a long story short, he argued that the tanker/supply and escort maintenance ships weren't enough to answer the RCN's needs for underway replenishment. Boulton's proposal was recommended to the Naval Board in March 1959, but had trouble getting past the estimated $14 million per ship. Further study of the subject was called for. It took another 13 months for Cmdre Boulton to complete his new study, and although he agreed the tanker/supply ships and the Cape ships would be able to provide various types of fuel and stores, he still maintained the need for fleet issue ships for the RCN. It was to no avail. During the PPCC's review of the proposal on June 7, 1960, approval for such vessels was withheld. The fleet issue ships would, instead, be placed in the long-term forecast of RCN requirements.

For all practical purposes this decision left the tanker/supply ships as the sole vessels capable of large-scale replenishment at sea for the near future. The tanker/supply ship soon to be laid down had quietly become the object of one-stop shopping in replenishment at sea for the Royal Canadian Navy. The completion of the transformation of the new HMCS *Provider (2nd)* — the name chosen by the Naval Board in December 1960 — from tanker to operational support ship would extend beyond the laying down of the hull, through construction, and into operations.

Acknowledgment: I would like to thank my colleagues at the Directorate of History and Heritage, Dr. Isabel Campbell, Lt(N) Jason Delaney, Lt(N) Richard Mayne and Michael Whitby for their advice and assistance on this paper. Comments are welcome, and may be addressed to: Reynolds.K@forces.gc.ca

Dr. Ken Reynolds is an historian with the Directorate of History and Heritage in Ottawa.

HMCS *Provider* with two Improved Restigouche-class destroyer escorts hooked up for underway refuelling in 1983. HMCS *Gatineau* (IRE-236) is on *Provider*'s port side.

Introducing...

Women in Defence and Security (WiDS) Canada

Article by Brian McCullough

Women have been making significant contributions to our nation's defence and security throughout Canadian history. Whether on the home front or the front lines, Canadian women have answered the call with their own kind of perspective, strength and determination. Today, talented and capable Canadian women in unprecedented numbers are continuing this great tradition in positions of responsibility across the Canadian defence and security establishment.

In 2005 a not-for-profit organization was established to promote the advancement of women leaders in the defence and security sectors of government and industry. Women in Defence and Security (WiDS) Canada seeks to increase the number of women employed in defence and security, and to advance their involvement and representation at senior levels. The association provides a forum for professional development, the exchange of ideas and experiences through various networking opportunities, and even offers a scholarship fund and mentorship program. Just as important, WiDS is also a vehicle for communicating the merits of a career in defence and security to all women in Canada.

WiDS is affiliated with the Canadian Association of Defence and Security Industries, an industry-led association of more than 400 defence and security firms in Canada. It is also a chapter of the American-based Women in Defense, which provides its members with opportunities for professional development and networking, and cultivates the advancement of women leaders in government and industry.

In today's post-911 environment, the public and private sectors are sharing greater interdependence in delivering security measures to mitigate threats and ensure that Canada's population is safe. WiDS is part of this process. Promoting opportunities within the defence and security field to women will broaden the pool of capable resources to contribute to Canada's national security.

At the request of the *Maritime Engineering Journal*, three bright and energetic female members of the naval technical community agreed to share their stories with us. While quite different in the details, the experiences of engineering **Petty Officer First Class Cheryl Bush**, engineering **Lieutenant(N) Mélanie Mountan**, and DND chemist **Sue Dickout** share a common thread of positive attitude, professional competence and unqualified success in their chosen careers. We hope that women and men everywhere find inspiration in their accomplishments.

Many thanks to Sarah Pike, Communications Director for WiDS Canada, for assisting with this introductory segment. The support of WiDS Canada President Wendy Allerton is also gratefully acknowledged. WiDS Canada can be reached through their website at:
www.defenceandsecurity.ca

The original WiDS executive at the organization's launch on March 2, 2005. The launch was attended by Gen. Rick Hillier and VAdm (ret.) Gregg Maddison, Patron for Women in the Forces at the time of the event.

Back row, left to right: **former treasurer Michelene Zdunick, former associate director Heather Herman, marketing director PO1 Cheryl Bush, communications director Sarah Pike, and VP (events) Suzanne Belanger.**

Front row: **VP (finance and membership) Anne Healey, VP (programs) Louise Mercier, president Wendy Allerton, and vice-president Anne Carroll.** ***(Missing were: VP for public relations Lisa Dudzik, sponsorship director Lynne Leier, and associate director Judy Blundon.)***

Experiences of a (Female) Petty Officer First Class, Canadian Navy Reserve

Article by PO1 Cheryl Bush, CD

How time flies! I've just completed my 20th year in the naval reserve, most of my service on active duty. I'm a marine engineering system operator, and a qualified chief engineer on board the maritime coastal defence vessels. My engineering log shows steaming hours on the deck plates of the now decommissioned DDH steam destroyers, gate vessels, minesweeping auxiliaries, and the soon-to-be-decommissioned yard auxiliaries, plus time on board HMCS *Protecteur* (AOR-509) and various MCDVs on both coasts.

It was my high school guidance counsellor, a former reservist, who encouraged me to join the naval reserve. In 1985 I got a summer job through the SYEP Summer Youth Employment Program, a military training program funded by Unemployment Insurance Canada. That fall I took it a step further and joined the reserves at HMCS *Chippawa* in Winnipeg, Manitoba. I loved it. Having grown up on a farm northeast of Winnipeg, in Tyndall, MB, and worked in the fields and been around tractors and other farm machinery, I decided to join the engineering branch. It seemed like a challenge, and training was on the West Coast (the East Coast seemed too far away).

My parents were very supportive of my decision, even though they knew nothing about the military. The navy seemed worlds away from the farm, but once I had my engineering "A" ticket I would fly out to the West Coast with my naval reserve division almost every weekend for sea training in the gate vessels. My parents were (and still are) very proud of me.

Over the past 20 years I have had the pleasure of experiencing and participating in numerous "firsts" for women in the Canadian navy, including the original trials for women at sea on board HMCS *Protecteur* in 1988. The diving support vessel HMCS *Cormorant* (ASXL-20) had carried women from the "purple trades" (e.g. clerks, medics), but *Protecteur* was the first naval ship manned by regular force personnel to sail with women employed in the hard sea trades. This wasn't the first time I'd ever sailed with a mixed gender crew, however. The naval reserve had been carrying mixed gender crews since the late 1970s. Still, it was a great experience to participate in the *Protecteur* trial, especially since the ship was finishing off a NATO deployment.

Photo: Brian McCullough

PO1 Cheryl Bush

The next time I sailed with the regular force was on board HMCS *Ottawa* (DDH-229) during her Great Lakes decommissioning trip in 1992. It was the first time *Ottawa* had embarked women as part of her crew. I was the senior female NCM on board, and the first female member of no. 3 mess (although I'm not sure that's something to brag about). On this trip I understudied the CERA (chief engine-room artificer) as I worked toward my own chief engineering qualification. What an opportunity it was for me to work with the various engineering trades and to experience the running of a large engineering department. It was a luxury we don't often get to experience on board most reserve vessels, and certainly not aboard the old gate vessels. I still remember punching fires down in the boiler-room, and conducting rounds on the "vaps" (evaporators).

Other highlights of my career include qualifying as a ship's team diver and dive supervisor, again at a time when women were just entering the regular navy hard sea trades. For three years I worked as a fire-fighting and damage control instructor at the Canadian Forces Damage Control and Fire-fighting School in Halifax. From this posting I was selected as the first woman to attend the Royal Navy "10s" course for senior HQ-1 level NCMs (i.e. Chief ERA, Chief Hull Tech, Chief ET) at HMS *Excellent* in Portsmouth, England. It was an honour to have been selected to represent Canada — and a surprise to the Royal Navy. This course is taught to senior rates, and when I attended the course in 1996 the RN had been accepting women into seagoing trades for less than a year. They were still experiencing growing pains, and certainly didn't yet have any female senior rates in a hard sea trade.

I eventually qualified as a chief engineer on board the gate vessels and maritime coastal defence vessels in the mid-1990s, a time when there were very few female chief engineers. Today, I work for the Chief of the Maritime Staff in the navy recruiting cell in Ottawa where I am working on raising the profile of the Canadian navy and increasing the number of recruits into the navy.

With my military work experience and the opportunities I've had, I certainly feel that I represent the fundamentals of Women in Defence and Security (WiDS). If you are interested in more information, please visit our website to learn more about the WiDS objectives and what we have to offer.

PO1 Cheryl Bush is the Chairperson for Marketing and Membership for the first Canadian chapter of WiDS. She lives in Ottawa with her husband, retired navy Cdr Bob Bush.

One (Female) Engineer's Experience

Article by Lt(N) Mélanie Mountan

People often used to ask me why I joined the Canadian Forces, but they don't as much anymore. I figure being a woman in the CF is so common now that it does not generate the same interest.

I grew up in Sherbrooke, Québec and joined the Canadian Forces right after high school in 1996. I wanted to be an astronaut, and it seemed like all the astronauts had military training. I watched Julie Payette become the first *Québécoise* astronaut, which impressed me with her achievements and aptitudes, but her success ended my hope of becoming the first Québec woman to travel to space. I soon had to forget about becoming an astronaut entirely when I was told that my eyes were not good enough, so I focused (!) on becoming a marine systems engineer instead.

I thank my father for signing the joining application — I was 17 at the time — even if he did make remarks about women in the military. "It is your life," he told me. And a remarkable life it has turned out to be.

My interest in engineering was another driving factor in my choice of a military career, so attending the Royal Military College (RMC) seemed a good path to follow. And it was. My father is a mechanic and welder, and I spent time following him around in the garage when I was

Lt(N) Mélanie Mountan (neé Leblanc)

younger. My mother likes to read a lot and had tons of books I could use for research. I believe this is what made me like engineering. I am proud to be an engineer, and I have achieved one of my life's goals.

I completed a preparatory year at St-Jean-sur–Richelieu prior to attending RMC, and eventually graduated in 2001 with a bachelor's degree in electrical engineering. My marine systems engineering training included a six-month training journey to Gosport, England for the Support to Engineering and Maintenance Course (SEMC). Other than the language barrier that caused me some grief at first, this experience was one of the best. A course in England is still just a course, but the opportunity to travel, to learn about other navies' engineering and systems and to meet different people made this experience great. I found that the Canadian people I worked with, compared to some of the English, focused more on rank, trade, position and expertise than on gender. I think, even now, that our navy is more comfortable with the concept of gender equality in the military workplace environment than our British allies are.

I was posted to HMCS *Fredericton* for almost three years to complete my head of department training. It is interesting to note that the MSEO (marine systems engineering officer) during my first year-and-a-half on board was one of the Canadian navy's first female engineering officers. I enjoyed my time on the *Freddy*, and was fortunate to see a complete operational/maintenance cycle that included low-readiness operations, workups, high-readiness operations such as Op Apollo, a docking work period and other maintenance and trials. There was one downside, however. Like other sailors, men and women alike, I found being away from my loved ones for over four months at a time very hard.

In the summer of 2005 I was posted to the submarine class desk in Ottawa as the submarine configuration change manager, and frankly I was not too keen about it at first. Fortunately, it has turned out to be quite a good place to work, with valuable challenges and great people. Although I am still figuring out this new world, I now appreciate the vast experience of the people in our naval technical community and the challenges they have to overcome to put in place new equipment and projects. For those who are wondering if I am interested in becoming Canada's first female submarine engineering officer, the answer is a resounding *No!* What would really interest me, though, would be to become the engineering officer of one of the new single class surface combatants when they are built.

I have been in uniform for 10 years, now, and would like to continue my naval service beyond 20 years. There is a simple reason for this. As I often say to people, I have the best job in the world!

Lt(N) Mélanie Mountan and her husband, CPO2 Phillip Mountan, both work in DGMEPM in Ottawa. She enjoys riding her motorcycle, playing pool with her husband and friends, and playing the piano. Mélanie is part of the NDHQ women's volleyball team, and likes running and weight training.

A Female Civilian's Perspective in Defence

Article by Sue Dickout

When I started working as a chemist in DGMEM in 1980, I was the only woman in a technical job in the division. Since procurement professionals at that time were in a separate division, all of the other female civilians were in clerical or administrative positions. The only female military members were also administrative. It was quite a few years before women were accepted into hard sea trades and began to appear in engineering jobs. Some civilian female engineers joined DGMEM, or DGMEPM later on, but most didn't stay too long.

I hadn't planned for a career in government, but then I didn't have any definite plan. I came from a small town in southern Ontario and got my degree at the University of Guelph. When I graduated, among my many applications was one for a laboratory job in a federal department. That competition was cancelled, but I was rolled into new graduate inventory and a few months later got a call out of the blue for an interview with DND. I've been in this division ever since.

Starting work at DND was complete culture shock. I'd worked in university and food plant labs with small groups of people, but had never had the slightest contact with the military or a big bureaucracy. Both were startling and somewhat mystifying. (The attribute I found the most striking about my co-workers was that most of them had tattoos...but that was a long time ago.)

Photo: Brian McCullough

Sue Dickout

I was supremely lucky to work in a section staffed by fantastic people, both personally and professionally, who took a lot of care with me and brought me along. They helped me laugh at officers who tried to give me their typing or ignored my presence in meetings, and encouraged me to develop the confidence to stand up for myself. Each of us had our own specialty, so I soon had to take responsibility for my technical field. Early on, my boss taught me the most important thing I ever learned — that it was okay to make mistakes, as long as you made a decision based on the best information available, took responsibility if you were wrong, fixed things, and moved on. Making a mistake was always better than being afraid to make a decision and letting things fall apart or grind to a halt.

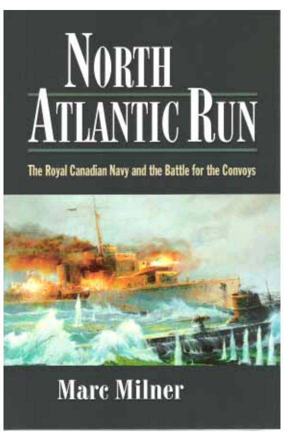
I don't think the division as a whole was welcoming toward women in technical fields. Officially it was, but I sometimes felt that my major value to senior management was to score gender points in their annual reports. I was lucky not to end up in sections where the presence of women was resented and discouraged. There definitely were places like that in the division. Changes in attitude came over time, after women were being admitted into hard sea trades and as officers who had gone through military college with women arrived in the division. I'm sure it wasn't easy for women being in those first classes, but it did make a big difference in attitudes. It's fantastic now to have 25 or 30 times as many female officers, engineers and technologists as there were in the division when I began.

The worst times in the division were during and after the major downsizing periods. So much experience and talent walked out the door, and it was difficult to see how those of us who were left could fill the gaps. Somehow we got things done, but if you are a newer arrival you can hardly imagine how much of a relief it is to actually have new employees for the first time in 10 or 15 years, to have fresh energy and viewpoints. The period coming up, with new ships and new projects on the horizon, will be so interesting.

I've stayed in DGMEPM because I have always had interesting and varied work to do. I have been responsible for chemicals, for fire-testing shipboard furnishing materials, for fuels and lubricants, and for all kinds of miscellaneous materials. I have always found the most satisfying type of work to be judging a technical problem and making a decision, and I've never run out of technical problems. As well, I have had many opportunities to travel and collaborate with specialists from other navies, and to represent Canada.

The biggest challenge ahead for the division now is to recruit and train the people who will be taking on the next round of projects. As we look ahead, I believe that the contribution of women to DGMEPM in technical positions and at senior management levels will continue to grow. All being well, this time around the newcomers will have an opportunity to benefit from the knowledge of the experienced hands (many of whom will be retiring in the next five to 10 years) before they have to make the decisions that will be demanded of them.

Sue Dickout has worked in DGMEPM since 1980. She is presently the subsection head for Materials and Hull Outfit in DMSS 2. Her husband, Maj Bruce Monahan, is an EME officer in DGLEPM.



Book Announcement

A very popular book, *North Atlantic Run*, has been released in a new paperback edition from Vanwell Publishing Ltd. A full review will appear in the next issue of the *Maritime Engineering Journal*.

In the meantime, Vanwell is offering *North Atlantic Run* to readers of the *Maritime Engineering Journal* at the special price of $17.95 per copy, which includes free shipping and GST. When you order from sales@vanwell.com, remember to mention that you are a *Journal* reader in order to get the special price. Vanwell has an interesting and diverse naval/military history booklist. Be sure to ask for their catalogue.

Guidelines for Book Reviewers

The *Maritime Engineering Journal* is always on the lookout for upbeat, positive reviews of recently published naval/nautical books. Reviews should be about 250 words in length, and should generally tell us:

- what the book is about
- how well the author did with the work, and if there are any minor drawbacks
- what you like best about the book [the main focus of your review];
- whether the illustrations work well;
- whether there are any particular groups to whom the book might appeal.

Please mention the book's title, author name, publisher, date of publication, ISBN and number of pages.

Also mention whether the book contains photos, illustrations, glossary, bibliographical references or index, and send us a high-resolution scan of the dust cover if possible.

Reviewers are encouraged to express themselves creatively, and in their own words.

Feel free to contact me if you care to discuss a potential review. Happy reading!

Brian McCullough
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Simulation Technology:

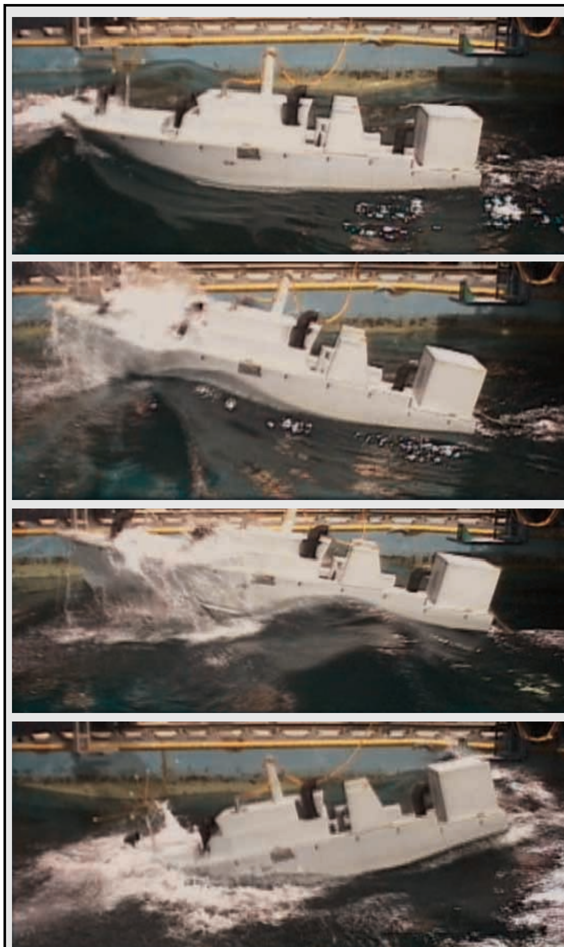
Operational Capabilities in Heavy Seas

Article by Michael Dervin

Naval ships are typically required to be fully operational in up to sea state 6 — conditions expected 80 percent of the time in the North Atlantic — with a minimal reduction in capability in higher sea states. Capability with respect to habitability, weapon system effectiveness and equipment operation are all important. Traditionally, part of the engineering challenge in designing a ship has been adequately predicting its operational capabilities in heavy seas for various combinations of operational scenario and environmental factors. Advances in ship motion simulation technology now make this possible, giving naval engineers the tools they need to assess a ship's heavy weather capabilities. This is all very useful for verifying aspects of contract compliance when new ships are being introduced to the fleet, and for assisting commanders when drafting operational guidelines by illustrating the apparent operational limits of a given vessel.

Operational Criteria

The key to evaluating performance capabilities in heavy seas is identifying meaningful criteria that capture the factors that degrade and ultimately limit operations. Ship motion responses such as roll and pitch angles, or frequency of keel emergence (an indicator for slamming) have long been used to determine when operations have become impaired or conditions intolerable. Today, rather than infer operability indirectly through ship motion responses, the trend is to identify and quantify the physical factors that limit operations. The result is a more accurate picture of a ship's likely operational performance.



In this series of video frames, a model of a *Kingston*-class coastal defence vessel struggles through scaled-down "heavy seas" in a model test tank. Data from such model testing is of enormous value for validating ship motion simulation programs. *(Courtesy National Research Council of Canada Institute of Ocean Technology)*

A key operational factor in any sea state is the ability to freely choose the ship's speed and heading. In heavy seas a commanding officer may be compelled to reduce speed and/or change heading in spite of the mission's objectives to mitigate the damaging effects of slamming. The potential damage due to slamming extends beyond the obvious deformation of the bow's bottom plating and supporting structure. Damage to the sonar dome and bilge keels is possible (*Fig. 1*), as are structural fatigue and whipping in the mast and antennas. Whipping is essentially a vibration or shock that travels through the ship's structure and can damage the ship's mast, equipment mounts and aerials.

The Department of National Defence has conducted extensive tests with a flexible (hydroelastic) model of a *Halifax*-class ship to measure wave-induced bending, shear, and torsional hull girder loading (*Fig. 2*). Other experiments with a *Kingston*-class model (*this page*) have used pressure transducers in the hull's shell to measure local hull plating wave-impact loads. Such model test data and ship-trial measurements can be entered into a structural analysis program to assess structural loads and deflections. Based on such analysis, design limits and risk assessments can be equated to the actual structural capacity and the nature of a slamming event (magnitude, distribution and duration of the slamming pulse) to more adequately assess the vessel's limits while operating in heavy seas. Several seakeeping simulation programs now include calculations for a ship

Fig. 1. The potential damage from hull-slamming extends beyond the obvious deformation of the bow's bottom plating and supporting structure. Damage to the sonar dome and bilge keels (*right*) is also possible, as are structural fatigue and whipping of the ship's mast and antennas. *(DND photos)*

operating in a particular seaway, for longitudinal bending, shear force and torsion loading output, and for predicting slam loads. To address dynamic loading, standards, criteria and operator guidance can now be based on the ship's characteristics in a realistic seaway rather than on formulae with built-in margins.

From a human performance perspective, location-specific "motion-induced interruptions" are now commonly used in operability analyses. Multiple factors such as deck angle, the deck's coefficient of friction, a person's height, weight and stance, and vertical and horizontal accelerations and wind speed are all combined to evaluate whether a person (or an object such as a helicopter) will tip or slide on the deck. A high frequency of motion-induced interruptions is a strong indicator that ship motion would prevent a crew member from safely and effectively completing a given task due to the person stumbling or having to hold on. As the frequency of motion-induced interruptions increases, intricate work and walking become increasingly difficult, heavy manual work becomes dangerous, and people suffer from motion-induced fatigue and seasickness. All these factors that contribute to the operability of the ship and its systems can now be objectively assessed rather than estimated.

Consider the ship's gun. To maintain target lock, the mechanical systems that train the gun on its target must counteract the ship's motions, which typically results in the barrel-tip vertical velocity being the gun system's limiting motion criterion. In other words, there comes a point where the motion is so violent that the target-lock systems can no longer keep the gun trained and elevated onto a target. With simulation software, this is something we can now specifically evaluate as part of a de-

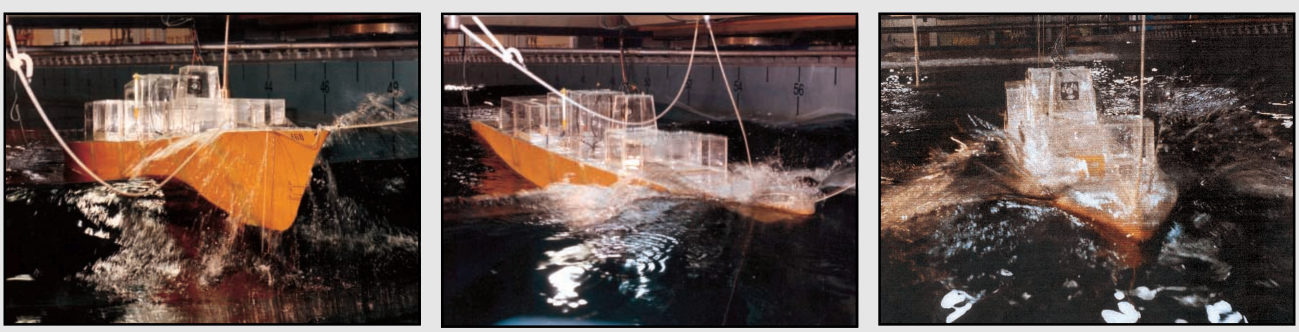


Fig. 2. The Department of National Defence has conducted extensive tests with a flexible (hydroelastic) model of a *Halifax*-class ship to measure wave-induced bending, shear, and torsional hull girder loading. Other experiments with a *Kingston*-class model (*see page 15*) have used pressure transducers in the hull's shell to measure local hull plating wave-impact loads. Model test data along with actual ship trial measurements can be entered into a structural analysis program to assess the structural loads and deflections a ship might encounter in a seaway. *(Photo courtesy National Research Council of Canada Institute for Ocean Technology. Illustration courtesy Defence Research and Development Canada – Atlantic.)*

sign review or an operability analysis.

A ship's dynamic stability, whether the ship is intact or in a damaged condition, is a critical component of its operability and survivability in a given seaway. The technology to simulate and assess the risk of capsizing in heavy seas now exists. Furthermore, the transient effects of, for example, progressive flooding in a ship in heavy seas can now be modeled. Previously it was only practical to consider the flooded end-state condition of a ship using criteria with built-in safety margins. But as a ship floods, the dynamics of water moving within the ship and the ship's motion in the seaway may create transient stability conditions outside of safety margins that are worse than the flooded (possibly stable) end-state condition. Based on the predicted dynamics of the ship in a seaway, current standards can be modified, augmented or replaced. Methods to exploit these simulation technologies, along with rationally based criteria accounting for dynamic and transient stability in a seaway are currently being developed.

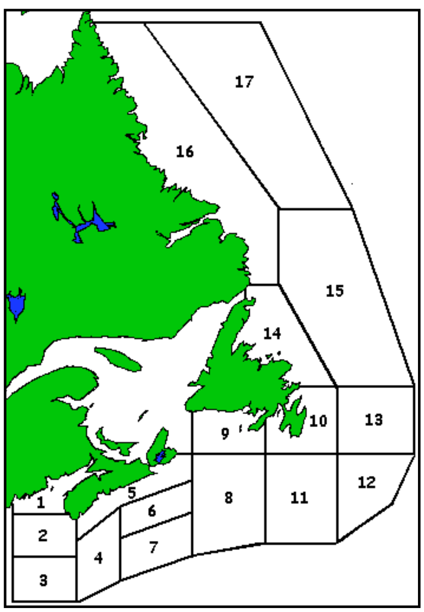


Fig. 3. An intricate aspect of assessing operational capabilities in heavy seas is the definition of the seaway itself. A seaway environment can be defined either as a singular seaway, characterized by a wave height, wave period and spectrum, or as a particular zone of operation as large as the North Atlantic or, as illustrated here, as small as a specific maritime coastal area. *(Courtesy Transport Canada Transportation Development Centre)*

As one would expect, certain aspects of a ship's motion in a seaway place limits on how well various operations can be completed, if at all. A 15-degree roll might not badly affect a ship's patrol transit, but it could have more serious implications during helicopter launch/recovery operations. For ship-motion predictions to be most useful, the simulation needs to be as accurate and specific to each ship operation as possible. In other words, for every ship-specific operation, limiting criteria such as deck wetness, roll, vertical velocity at the bow, etc., need to be identified and linked to allowable thresholds. With this critical data and seaway conditions entered in the simulation program, a ship about to launch a helicopter could easily call up a computerized graphical display of the operable envelope for ship heading and speed to allow the helicopter operation.

To simplify the process of identifying ship-motion operability criteria and establishing operable thresholds, operations can be subdivided into specific *missions* (e.g., anti-submarine warfare, fishery patrol) and *tasks* (e.g., landing a helicopter on deck, launching weapons, conducting replenishment at sea, executing a Williamson turn). This makes it possible to tailor criteria sets with appropriate limiting values specific to each mission and task.

Depending on the objectives of an analysis, criteria can be developed around specific scenarios such as a requirement to remain afloat for 30 minutes to permit evacuation after a torpedo hit in sea state 5; or, sufficient structural resilience and residual stability to enable repairs after a missile hit in sea state 4; or, sufficient residual stability in sea state 5 to launch the helicopter; or the ability to regain propulsion and manoeuvring capability 60 minutes after flooding of any two compartments. Here, ship motions, structural resilience, primary and auxiliary machinery functionality and human factors would all be aspects of the analysis. Similar scenario-driven, time-dependent analysis is used in certain submarine operating envelope calculations where a boat's dynamic response is evaluated. Factored in are such things as the time required to change speed, blow ballast and manoeuvre, all considering human and machinery response times.

Although simulation and analysis tools are largely available, they have so far been used in an ad hoc manner to evaluate mission-specific operability and seaway limiting conditions for unique scenario cases. The focus of much of the research and development activity now under way is centred on developing clear standards and criteria.

The Seaway Environment

An intricate aspect of assessing operational capabilities in heavy seas is the definition of the seaway itself. A simple seaway environment can be defined either as a singular seaway characterized by a wave height, wave period and spectrum (i.e. the distribution of wave heights and periods), or as a particular zone of operation as large as the North Atlantic or, as illustrated in *Fig. 3*, as small as a specific maritime coastal area. With a zone chosen, a season or month (rather than a whole year) of wind and wave data can be used to describe the range and frequency of the different sea conditions that can be expected. For a mission that will cross several zones, results can be predicted for each phase of the voyage as the ship passes from one zone to the next.

Results are often presented as a percent-time-operable (PTO) value for each zone or combination of zones, factoring in such things as the ship's speed and choice of heading. A PTO of less than 100 percent may be quite acceptable, recognizing for

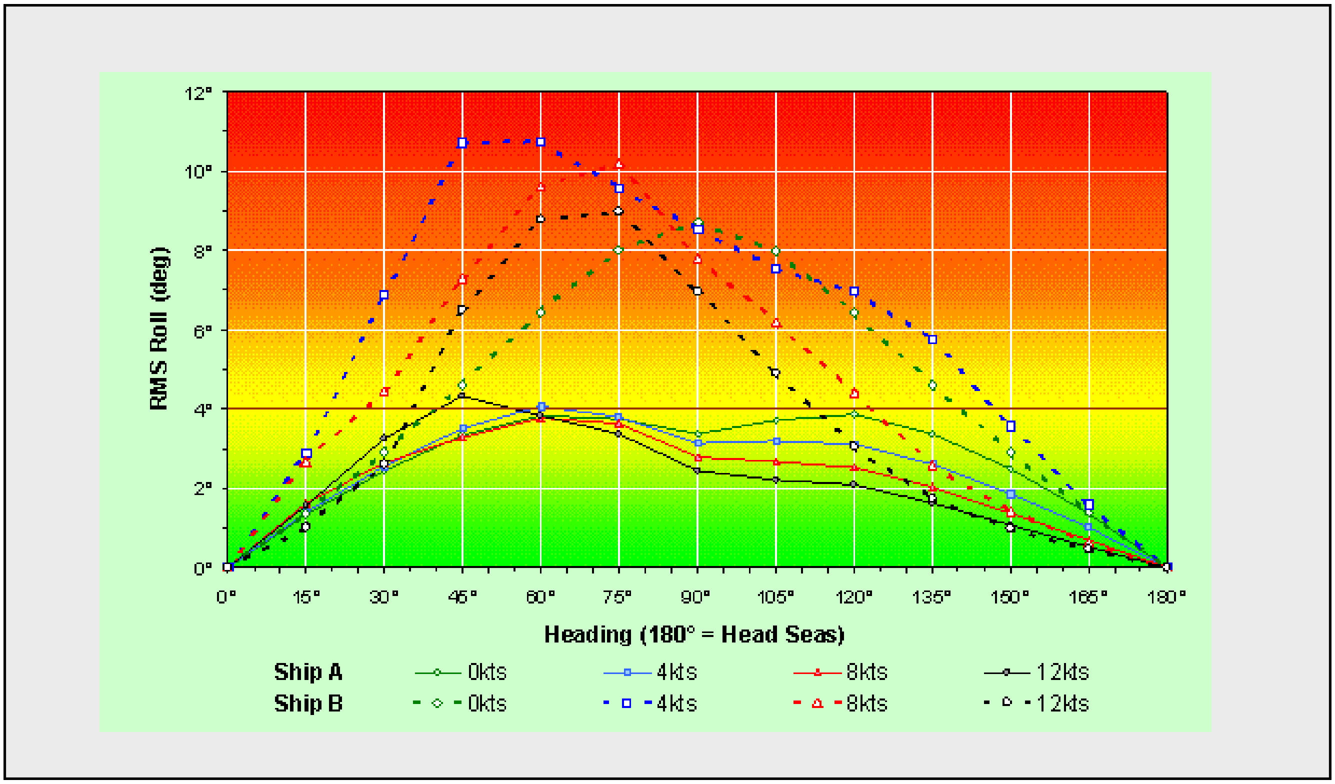


Fig. 4. A traditional depiction of a single motion response (roll in this case) for a single seaway as a function of a ship's heading relative to the waves. In this graph, roll data for two different notional ships (A and B) are plotted to illustrate the much-different implications of various speeds (0, 4, 8 and 12 knots) for each ship. Strictly from a roll perspective in the given seaway, ship A is clearly superior. Background colours can be used on the plot to represent levels of operability or risk depending on the intent of the presentation. In this illustration the NATO 4° RMS (root mean square) roll limit for a transit and patrol mission has been plotted as a solid horizontal line. ***(Courtesy the author)***

instance that storms can often be avoided and operability improved by altering speed or heading relative to the waves without significantly affecting the overall mission. Using a more traditional singular seaway approach, analysis results are directly compared to mission-specific thresholds (e.g. the degree of roll allowable during replenishment at sea operations), noting at which speeds and headings relative to the waves that the threshold values may be exceeded.

Applying the Technology

Figure 4 is a traditional depiction of a single motion response (roll in this case) for a single seaway as a function of a ship's heading relative to the waves. Roll data for two different notional ships (A and B) are plotted to illustrate the much different implications of various speeds (0, 4, 8 and 12 knots) for each ship. Strictly from a roll perspective in the given seaway, ship A is clearly superior. Background colours can be used on the plot to represent levels of operability or risk depending on the intent of the presentation. In this illustration the NATO 4° RMS (root mean square) roll limit for a transit and patrol mission has been plotted as a solid horizontal line. In similar fashion, other factors such as motion-induced interruptions or slamming frequency of a particular magnitude can be depicted. Rather than plotting multiple speeds for one seaway, it is possible to also plot multiple seaways for one speed.

A heading polar plot is another way to illustrate operational limitations. In *Fig. 5* the data represents a ship travelling at one speed under a range of sea conditions, from calm at the centre to six-metre seas at the perimeter of the plot. The zones in the illustration represent different vertical velocities measured at the bow (often the limiting factor for maintaining gun target lock). Using this plot with an example vertical velocity limit of 1.0 m/s, one can effectively determine that the limit is exceeded in two-metre head seas (a ship heading of 180° relative to the waves), but improves to four-metre seas when the seas are on the beam. This type of knowledge has obvious tactical value to operators, but is also important from a requirements, specification and design perspective during new-ship acquisition or midlife refit. It is important to note that these methods can be applied to many different ship systems and functions.

Vertical velocity at the bow is also a forewarning of conditions likely to cause slamming. Each zone in *Fig. 5* can be treated as a crude measure of risk with regard to slamming. A variation of this can be seen in *Fig. 6*, a slam probability diagram for one seaway, covering a range of speeds from zero at the centre to 12 knots at the outer ring. Here the slam probability is based on the ship's structural response exceeding a preset limit, and it is interesting to note how little transition there is from the low probability zone to the high probability zone (a function of the physics of slamming and this particular ship's geometry and structure). Such a presentation effectively provides operators with guidance on slam-avoidance, and has been used in the Canadian Forces Technical Bulletin, "Technical Guidance to Minimize the Probability of Slamming Damage on *Kingston* Class Vessels.[1]"

It is often desirable to combine individual criteria to represent a multitude of factors that would limit mission operability in a seaway. Tailored to the mission objectives and associated tasks, criteria sets can be used to determine an operability envelope for that specific mission. *Figure 7* is just such a plot for a transit and patrol mission, considering one speed as a function of wave height. The shaded area indicates the envelope, or range of headings and seaways in which none of the criteria are exceeded. The circle set at four-metre seas is a target design limit corresponding to the high end of sea state 5. It is obvious that for some headings at this speed certain criteria fall outside the envelope. The labels around the perimeter indicate which criteria are exceeded first when the ship is on a particular heading.

Operational envelope diagrams can easily be generated to show multiple speeds for a single ship on the same plot. It is interesting to note that for some headings the operation-limiting wave height is almost the same regardless of speed, while on other headings the operable envelope can be expanded considerably by changing speed (as one would normally expect). While this type of presentation makes it easier to identify critical headings and understand the implications of speed, comparing the operability envelopes of two or more ships, say, to select the better one during acquisition or design, can still be difficult if the envelope shapes are different even if their sizes are identical. Furthermore, there is no indication as to how often a ship will be limited by actual sea conditions. To address this, statistical data for a specific seaway must be factored in.

By combining seaway statistics with measured or calculated limits when individual or multiple criteria will be exceeded, a percent-time-operable figure (PTO) can be determined for a particular ship on a certain heading at a particular speed in a given zone. Data for all speeds, weighted in accordance with each ship's speed profile (how much time is spent at each speed), and for all headings can be combined to find an overall percent-time-operable. *Figure* 8 is a percent-time-operable bar graph where each bar is the speed-profile-weighted PTO for a particular heading in the chosen zone of operation. Assuming equal weighting of all headings, the overall PTO would be the average of all bars, 87 percent in this example. As intended, the PTO is linked to a mission and its associated criteria set. For different mis-

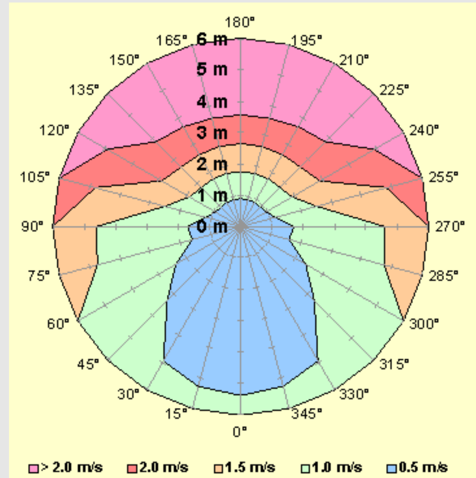


Fig. 5. This polar plot represents a ship travelling at one speed under a range of sea conditions, from calm at the centre to six-metre seas at the perimeter. The shaded zones represent vertical velocities measured at the bow (see text) in metres per second. Using an example vertical velocity limit of 1.0 m/s, one can effectively determine that the limit is exceeded in two-metre head seas (a heading of 180° relative to the waves), but improves to four-metre seas when the seas are on the beam. *(Courtesy the author)*

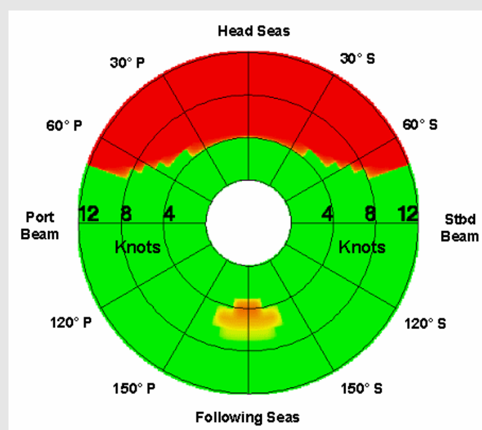


Fig. 6. This slam probability diagram is for one seaway, but covers a range of ship speeds from zero at the centre ring to 12 knots at the outer ring. Slam probability is based on a ship's structural response exceeding a preset limit. Notice in this example that there is little transition from the low to high probability zones. *(Courtesy the author, prepared with data from Defence Research and Development Canada – Atlantic)*

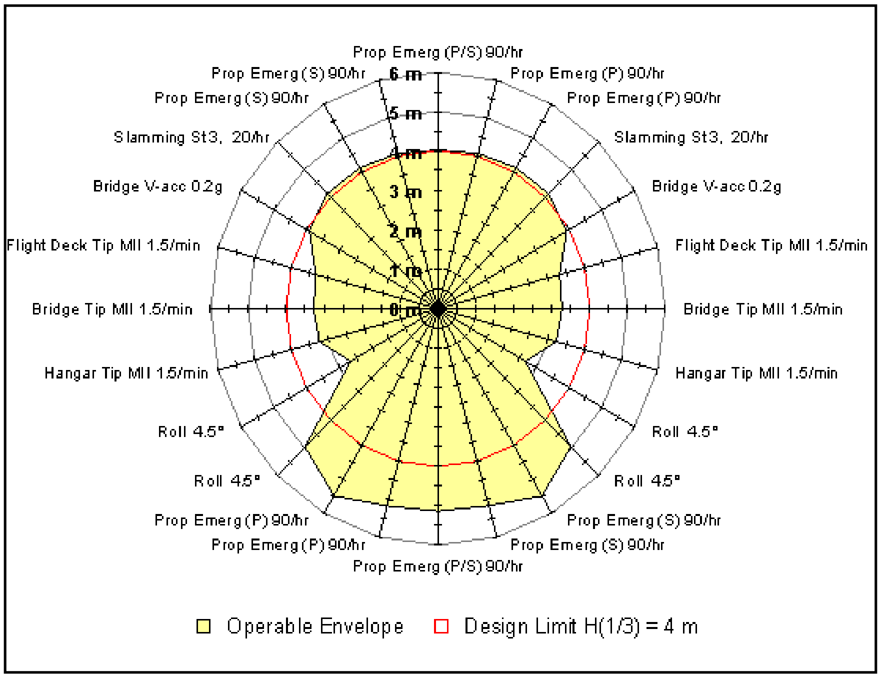


Fig. 7. This plot for a transit and patrol mission considers one speed as a function of wave height. The shaded area indicates the operability envelope, or range of headings and seaways in which none of the criteria labelled around the perimeter of the diagram are exceeded. The circle set at four-metre seas is a target design limit corresponding to the high end of sea state five. ***(Courtesy the author)***

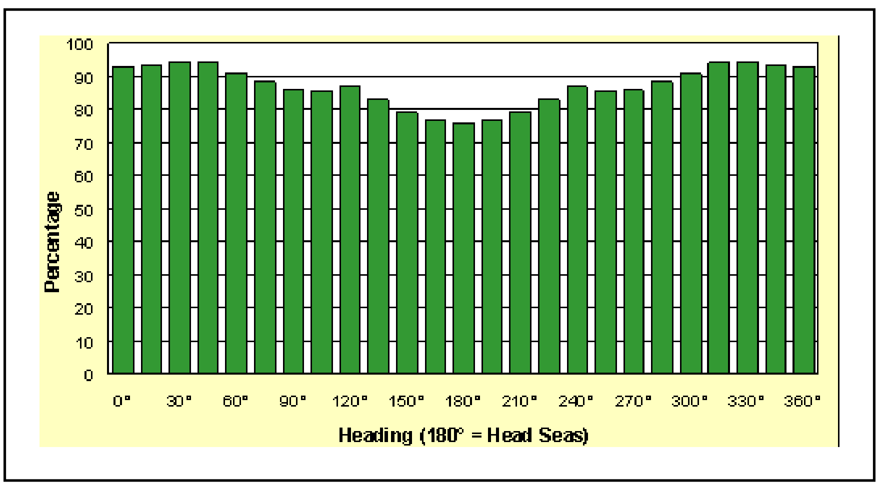


Fig. 8. By combining seaway statistics with measured or calculated limits when individual or multiple criteria will be exceeded, a percent-time-operable (PTO) can be determined for a particular ship on a certain heading at a particular speed in a given zone. Data for all speeds, weighted in accordance with each ship's speed profile (how much time is spent at each speed), and for all headings can be combined to find an overall PTO. In this percent-time-operable graph, each bar is the speed-profile weighted PTO for a particular heading in the chosen zone of operation. Assuming equal weighting of all headings, the overall PTO would be the average of all bars, or 87 percent in this example. ***(Courtesy the author)***

sions/criteria, the PTO would be different, and for something like replenishment-at-sea operations a limited set of speeds and headings would be used to better reflect that task.

Conclusion

These few examples illustrate the versatility and utility of applying ship motion simulation technology to maritime operational activities, and to ship/system acquisition and in-service support. The key to its usefulness lies in identifying meaningful criteria and associated limit values that reflect the operational limits of the ship, its equipment and its human performance. Although this article primarily addresses operability, a similar approach can be used to develop criteria for quantifying "withstand" or "survive" capabilities in severe sea conditions.

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Exploring the Wartime Wreck of HMCS Athabaskan —

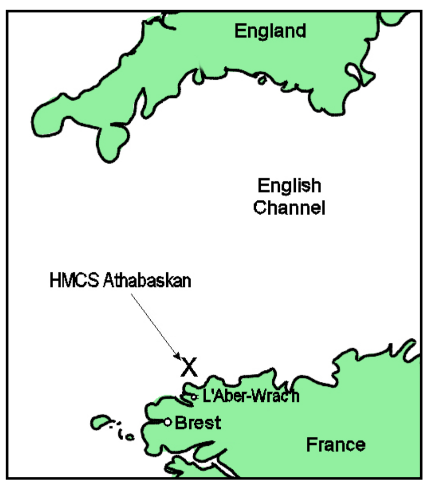
A Naval Architect's Adventure in Underwater Archaeology

Article by LCdr Jocelyn Turgeon, CD, P. Eng., PMP

Saturday, September 17, 2005. After leaving Paris earlier that day, Canadian-born journalist and diver Mark Ward and I finally arrived at our destination of L'Aber Wrac'h, a picturesque village 25 kilometres north of Brest on the Brittany shore of the English Channel. We were carrying with us a trunkload of photographic and cinematographic equipment, and diverse other items we would be needing for a somewhat unusual mission. For the next four days we would be working out of L'Aber Wrac'h as part of an international research effort to shed more light on the tragic wartime loss of the tribal-class destroyer HMCS *Athabaskan* (G-07).

The "Unlucky Lady," as this star-crossed ship was known, was sunk 10 km off the Brittany coast during a night action with two German *Elbing*-class destroyers in the early hours of Saturday, April 29, 1944. *Athabaskan* suffered two explosions on that fateful morning, the second one a violent blast that sent the ship to the bottom. The first explosion was probably the result of a German torpedo hit, although some attribute it to gunfire. But what caused the second explosion? The historical records create something of a controversy here.

Cdr Harry DeWolf, RCN, the CO of HMCS *Haida* which was in company with the stricken ship that night, testified before the naval board of inquiry, "I thought she was hit by gunfire aft and a very large fire started."[1] Did burning fuel then ignite the ship's after 4-inch ammunition magazine? Or was it a second torpedo hit that killed *Athabaskan*? Examined in hospital by the board of inquiry as he was recovering from burns, *Athabaskan* survivor Lt. J.W. Scott, RCNVR, testified: "We were following HMCS *Haida* and an explosion occurred aft and there were fires burning on the starboard side. I think [the first explosion] was a gun hit; I thought it was heavier than a 4-inch. [The second explosion was] on the starboard side. That was a definite torpedo because the whole ship just seemed to fall apart."[1]



Journal map

The confusion that night is evident throughout the inquiry testimony and after-action reports.[2,3] Even today, some people, including historian Peter Dixon, insist that *Athabaskan* took hits from a British MTB.[4] Other testimony points to a second torpedo hit on the destroyer's *port* side amidships.

It was all very confusing. We were optimistic that *Athabaskan*'s sunken remains might give up enough clues to dispel this controversy once and for all.

The First Expedition

During a first diving expedition to the site in the summer of 2003, our team located and identified the wreck of HMCS *Athabaskan*. Divers photographed the scene and attached a commemorative plaque honouring the 128 officers and crew who lost their lives in the sinking. The navy's Chief of the Maritime Staff (VAdm Ron Buck at the time) had set aside funds to pay for the plaque and all expenses relating to the deployment of a naval architect (see *In the Right Place...*). My background in naval architecture and ship structures was my primary contribution to the expedition, but I ended up happily performing many roles from driver to interpreter.

The 2003 expedition was a success in that we found a large piece of *Athabaskan*'s remains on the sea bottom, but the crucial stern section with the propellers and after guns remained hidden. Back in Ottawa I enlisted the help of several co-workers from the Ship Systems Engineering section of the Directorate of Maritime Ship Support. Together we were able to confirm the identity of the wreck from the photographic and videotape material brought back from the site. We also were able to determine that there was no torpedo damage to *Athabaskan*'s port side amidships.

Despite these encouraging results, the 2003 expedition left many questions unanswered. Notably, *Athabaskan*'s stern, a critical piece of the puzzle, was never located, so we were not able to determine the exact cause of the second explosion that sent the ship to the bottom. We provided our conclusions to filmmaker Wayne Abbott who had participated in that first expedition, and his documentary, “The Mysterious Sinking of HMCS *Athabaskan*,” was released on History Television on April 29, 2004, the 60th anniversary of the sinking.

The expedition received coverage in the national media, including the Canadian Forces newspaper *The Maple Leaf*. For my part, I gave presentations on the *Athabaskan* story to several groups, including one on behalf of the Society of Naval Architects and Marine Engineers (SNAME) during a river cruise in Ottawa on May 6, 2004. On the cruise that evening were Capt(N) Pat Finn and his neighbour Peter Ward, the son of Lt. Leslie Ward who was lost with the ship in 1944. Moved by the story of the tragedy and the lives that were lost, Capt(N) Finn wrote in the Summer 2004 issue of the *Maritime Engineering Journal* that he “felt a reaffirmation of what we do in the navy....We may be engineers and technicians, but we are first and foremost sailors serving our country.”

Mark Ward also wrote about the expedition in the November 2005 *Reader’s Digest*. In “Honouring the Unlucky Lady,” Mark (the grandson of Lt. Leslie Ward) described his thoughts as he placed the memorial plaque onto *Athabaskan*’s remains on the sea bottom while his own father Peter sat in a boat nearly 90 metres overhead. It was the closest that the three Wards —father Peter, and the son and grandfather who had never known one another — would ever come to being together.

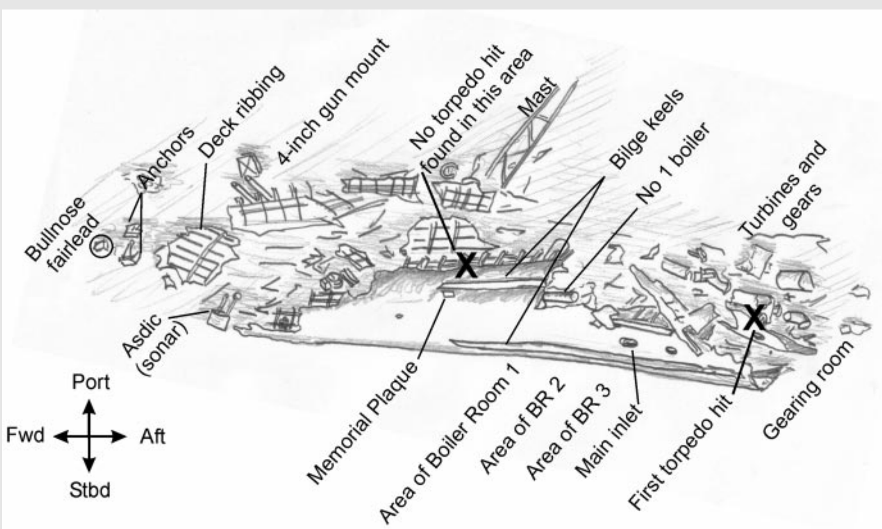
Fired by a desire to unravel the mystery surrounding *Athabaskan*’s demise, Mark Ward asked the Aurora Trust for Ocean Exploration and Education to sponsor a second expedition to the wreck in September

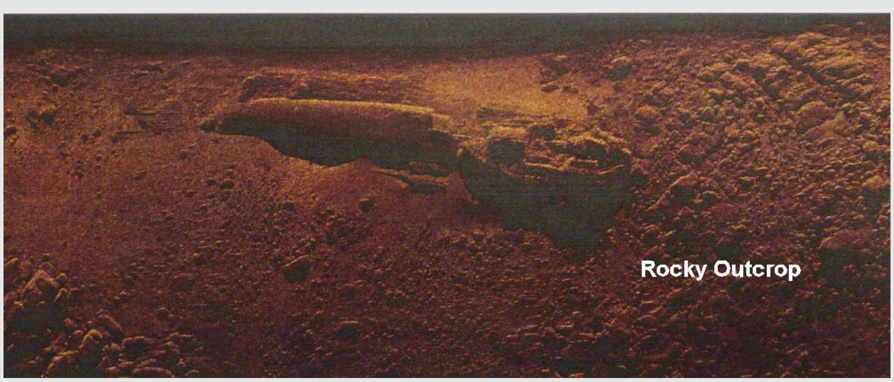
One of *Athabaskan*’s anchors photographed on the sea bottom during the 2003 dive expedition. *(Photo by Yves Gladu)*

2005. With luck they might find the stern of the ship and capture on film new images that would shed light on the true cause of the sinking.

The Second Expedition

In addition to expedition coordinator Mark Ward and me, the on-site research team included Aurora Trust director Craig T. Mullen, and navigator Frédéric Dubois and pilot Christophe Kerandren from SMF





The author created this sketch of *Athabaskan*’s wreckage based on video and still photos made during the 2003 expedition. The French naval hydrographic service GESMA produced the side-scan sonar image in 2004.

The comparable views show the ship lying more or less upside-down with its truncated bow pointing to the upper left, and the starboard side toward us. What’s left of the after end of the ship (heavily shadowed in the sonar image) is the point at which the first torpedo hit the gearing room. The ship lies end-on to an underwater rocky outcrop. The mast visible at the top of LCdr Turgeon’s sketch does not show well in the side-scan image due to the angle of illumination. Both the sketch and the image show a remarkable amount of detail, but not enough to clear up the controversy surrounding the second explosion that sent the destroyer to the bottom of the English Channel.

Europe, a company that specializes in high-resolution hydrographic surveys. In France we rekindled our friendship with Jacques Ouchakoff, president of a Brittany-based marine archaeological association (and the man who discovered the wreck), and cinematographer-diver Yves Gladu. Both of these men had participated in the first expedition, but would not be part of the team on this venture.

The second expedition had three objectives: (1) map the main section of the wreck; (2) scan the vicinity of the wreck to locate and map significant other debris; and (3) locate the after section of the ship and map it in as great detail as possible. There would be no diving during this expedition.

The mission plan called for Aurora Trust to subsidize the technical aspects of the operation, and for producer Wayne Abbott from Northern Sky Entertainment to film the expedition in anticipation of a second documentary. Northern Sky's participation hinged on an agreement-in-principle that funds would be provided by History Television, similar to their arrangement in producing the earlier one-hour documentary. With just days to go, however, we were dismayed to learn that History Television had pulled its funding pledge after re-evaluating audience interest for a second documentary. Northern Sky had little choice at this point but to withdraw from the project.

It was a devastating double-blow. Everything was in jeopardy until Mark Ward, who had experience with filming documentaries, agreed to take over the film aspects of the expedition. The limited funding and the few days remaining before our departure for Brittany left us with few options, but we decided to proceed with the expedition.

In mid-September Mark and I flew to Paris and made our way to L'Aber Wrac'h where we spent the first two days confirming arrangements and preparing for the sorties to the wreck site. Interestingly, we

In the Right Place... ...at the Right Time

Friday, July 11, 2003. It is a Friday like any other Friday at the height of the summer, and at 1600 hrs only a few people are still in the office. I'm busy closing some files and getting ready for the weekend. The following week I leave for England, as I do almost every month because of my work supporting certain projects involving the reactivation of the *Victoria*-class submarines.

But then something strange happens. Two people come into the DMSS 2 area, and since I'm the one guarding the fort I ask, "Can I help you?" And that's where the story begins. Capt(N) Eric Bramwell, a commander at the time, is accompanied by the manager of the director general's office. He answers my question with a question: Am I acquainted with the story of the wartime tribal-class destroyer HMCS *Athabaskan*, lost by enemy action in the English Channel in 1944? *Mais oui.* Even as a child I was interested in naval combat scenarios, and *Athabaskan*'s story was totally familiar to me: the Canadian destroyers *Haida* and *Athabaskan* confronting two German *Elbing* destroyers off the coast of France; the exchange of fire ending with the loss of *Athabaskan* and the start of a brillant career for *Haida* and her captain, Cdr Harry DeWolf. I knew it well.

And now Cdr Bramwell is telling me that a filmmaker has located the actual wreck site of HMCS *Athabaskan*, which apparently had not been correctly pinpointed. Filmmaker Wayne Abbott of Northern Sky Entertainment is looking for support from the navy through DND's chief naval historian, Michael Whitby. Mr Whitby has referred him to the local branch of the Society of Naval Architecture and Marine Engineering and more specifically to David Morris, a naval architect with DND. Unfortunately, with the departure date for the diving expedition on *Athabaskan* approaching so fast, David would not be able to participate. I was it.

Naval Architect LCdr Jocelyn Turgeon (left) discusses expedition details with Aurora Trust Director Craig Mullen on board *Survex 1* at the *Athabaskan* wreck site off the Brittany coast in September 2005. *(Photo by Mark Ward)*

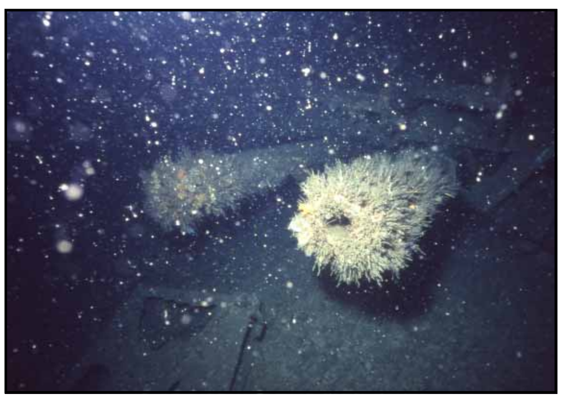
Over the next few days, David sent me the plans and documents he had gathered on the history of the *Athabaskan* and a video copy of Wayne Abbott's initial report on the recovery of *Athabaskan*'s crew. Three days later I left for England, having read and reread all the documents referring to this famous battle. And on Sunday, July19, instead of returning to Ottawa, I caught a plane from Bristol and crossed the Channel to find the film team in the small resort town of L'Aber Wrac'h on the north coast of Britanny across from Brest. Eight days later the curtain rose and my adventure commenced. I had been in the right place at the right time.

— LCdr Jocelyn Turgeon

In 2004 a highway roundabout near Brest was renamed in honour of *Athabaskan*'s sacrifice to France. At the nearby Monbarey Memorial, the names of the *Athabaskan* sailors who died can be found beside those of the citizens of Brest who lost their lives during the German occupation. A large section of the memorial is dedicated to telling the history of *Athabaskan*. *(Author photo)*

learned during one of our meetings that the French naval hydrographic service *le Groupe d'études sous-marines de l'Atlantique* (GESMA) had captured side-scan sonar images of the *Athabaskan* wreck a year-and-a-half earlier. We hoped that one of the GESMA side-scan images given to a Canadian delegation attending the official naming of the HMCS *Athabaskan* roundabout on a highway near Brest in the fall of 2004 might show the missing stern, but no such luck.

The dates for our upcoming expedition were chosen on the availability of the major players, including SMF Europe, a subsidiary of the French surveying company Comex SA retained to conduct two days of sonar surveys at the wreck site. Unfortunately, our window of opportunity (Sept. 17-20, 2005) did not offer much hope for ideal sea conditions. In fact, we would be facing some of the strongest tidal currents of the year, something in excess of six knots over the wreck. It did not bode well.



After more than 50 years on the sea bottom, *Athabaskan*'s guns are still recognizable.

Day 1 — Sept. 19, 2005

Early Monday morning we left L'Aber Wrac'h by boat for the 30-minute trip out to the wreck site where SMF Europe's survey vessel, *Survex 1* was already on station and waiting for us. We quickly located the wreck a few tens of metres away from its reported 2003 position and took new GPS readings. Based on our study of the battle report summaries and tide calculations for April 28/29, 1944, we established a roughly circular search area radiating 400 metres from the wreck. From this we extended a 300-metre-wide corridor to the southwest, the opposite direction in which the tidal current had been flowing at 0400 on April 29, 1944. We reasoned that debris would have fallen along this corridor as the current carried the sinking ship to its present resting place against an underwater rockface.

The hull-mounted multibeam scan survey began extremely well in surprisingly good weather and sea conditions, but as the day progressed it became apparent the equipment was not entirely happy with the 87-metre depth at which the wreck was lying. We figured the accuracy of the scans would probably be no better than about 30 cm^2 after processing, but should yield sufficient detail of the ocean bottom near the wreck to identify candidate areas for higher resolution side-scan imaging. A dozen points of interest were marked for the side-scan survey, as were a number of promising survey routes. The side-scan towed body would require careful handling in the strong current, especially near the rockface against which *Athabaskan* was resting.

Day 2 — Sept. 20, 2005

The weather was good on Tuesday morning as work got under way, but conditions deteriorated as the day went on. To make matters worse, because there weren't any dedicated winches on the nine-metre-long surveying vessel, the side-scan towed body had to be manhandled into position. This put a limit on the amount of cable we could safely handle, and effectively reduced the length of the cable we could pay out.

Consistent speed and depth are crucial for obtaining good side-scan sonar images, and our calculations showed that an operating "altitude" of about 20 metres above the wreck would ensure good illumination of any void spaces along the hull. This meant the towed body would have to plane at a consistent depth of 60 metres below the surface. Predictably, the towed body on its shortened cable was thrown around in the strong current and could not maintain a consistent planing depth for any extended period. The towed body changed heading and depth erratically, and on at least one occasion actually scraped the sea bottom. By late afternoon choppy seas forced a halt to the side-scan survey. We could only wait now for the processed sonar data to come back from Mesuris SaS, a subcontractor of Mesurex, to find out what we had.

Two weeks later the processed scan data was in hand. We were on tenterhooks. The multibeam data clearly identified the wreck of *Athabaskan* and the jagged contours of the sea bottom in its vicinity, but they had been able to extract nothing from any of the side-scan passes. The climbs and dives of the towed body had proved too unpredictable to be corrected by post-processing. There was now no chance of finding *Athabaskan*'s stern in the areas identified during the multibeam survey. We could go no further.

Aftermath

There was a bit of good news, though. The contract with SMF Europe had provided for only two days of scanning, but because of the dif-

Expedition vessel *Survex 1*

ficulties we encountered in deploying the towed body and the absence of any data from the side-scan sonar, SMF Europe agreed (opportunity permitting) to re-scan the key areas we identified from the multibeam data. Aurora Trust will pay a limited amount strictly for the data output. The team will also make a formal request to the French navy to obtain the 2004 GESMA data for in-depth study. Although GESMA obtained apparently very good quality side-scan images of *Athabaskan*'s wreckage, we do not hold much hope the pictures will show the missing stern.

So the mystery of the sinking continues. While the team did achieve two of the expedition's three objectives in relocating and mapping the main wreckage, and scanning the vicinity of the wreck site to map significant debris, the missing stern section — the likely key to the puzzle — remains to be found.

Expeditions such as these are important to our understanding of our naval heritage. *Athabaskan* made a significant contribution to the liberation of France, and her tragic sacrifice is a story worth telling. Although a third expedition is unlikely anytime soon, I remain a very interested participant in this project to unravel the mystery of the true cause of *Athabaskan*'s sinking. I intend to support the effort as my workload and free time permit.

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This photo taken during the 2003 *Athabaskan* dive expedition shows diver-journalist Mark Ward holding the memorial plaque he placed on the wreck. Ward is the grandson of Lt. Leslie Ward who was lost when the ship went down in 1944. His father Peter stands behind his right shoulder, and he is flanked by *Athabaskan* survivors Wilfred Henrickson (wearing the ball cap) and Herman Sulkers. The plaque reads: "At this site the people of Canada honour the 128 sailors who gave their lives in HMCS *Athabaskan*, sunk in action with the enemy, 29 April 1944. *Protect them whereso'er they go*"

LCdr Turgeon is a naval architect and Deputy Project Manager of the Single Class Surface Combatant (SCSC) Project in Ottawa.

Recertifying Submarine High-pressure Cylinders In Situ

Article by Daniel Laplante and Stanley Lyczko, Naval Engineering Test Establishment, and CPO2 (ret.) David Sankey, DMSS 4-3-6

High-pressure cylinders installed in submarines are used for built-in-breathing systems (BIBS), auxiliary vent-and-blow systems, and for nitrogen service. To reduce the risk of critical failure with this equipment, the marine auxiliary section of the Directorate of Maritime Ship Support (DMSS 4) in Ottawa requires that submarine high-pressure cylinders be recertified periodically. At the moment, recertification is carried out through a routine of visual inspection, partial ultrasonic inspection, and water bath pressure-testing which must be conducted ashore.

Removing HP cylinders from a submarine and reinstalling them again later is a labour-intensive and costly undertaking due to the amount of equipment and secondary structure that has to be moved or cut away to gain access to the cylinders and clear a removal route. A high percentage of the cost goes for rigging to move the cylinders through the submarine's narrow passageways and hatchways. Once the cylinders have been recertified and reinstalled ashore, everything has to be put back to rights — equipment that was removed has to be set back in position and made functional, fittings have to be reattached, and pipes have to be welded back together and undergo a significant amount of non-destructive testing to check the welds. It is a huge amount of work.

Looking for ways to simplify the task, the Naval Engineering Test Establishment (NETE) contacted the US Navy and the Royal Navy to learn more about their techniques for high-pressure cylinder inspection and recertification. State-of-the-art techniques in non-destructive testing (NDT) were also investigated to see if suitable alternative methods had been developed, specifically for conducting in situ inspections. From the research it was determined that it should be possible to inspect a cylinder's internal surface from *within* the cylinder. The investigation also revealed that the most appropriate methods of inspection were: *eddy current*, to inspect the internal surface for flaws and to provide corrosion mapping; *ultrasonic shear waves* to detect subsurface flaws; and *ultrasonic longitudinal waves* to measure wall thicknesses and to obtain a global view of cylinder wall erosion.

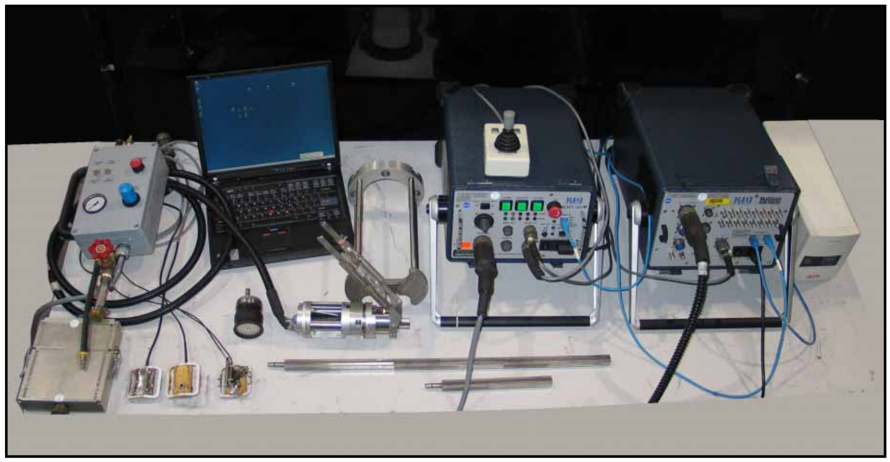

Fig. 1. This elegant suite of tools was specially designed for inspecting submarine high-pressure cylinders in-situ. At centre left is the open laptop computer with the cylindrical scanner unit resting in front of it. The scanner's three probe heads attached to their leads can be seen in the left foreground. At centre right is the motor-drive unit, and at far right is the data acquisition unit. The thin rods lying in the foreground are the rail sections along which the scanner travels.

Developing an in situ internal inspection process presented certain difficulties, the main one being the problem of simply gaining access to the cylinders in a submarine's cramped spaces. A typical cylinder is about 46 cm (18 in.) in diameter, but might have access clearance of only 30 cm and just a 10-cm neck opening through which to insert an inspection tool. Olympus NDT Canada Inc. (formerly R/D Tech Inc.), a company which specializes in automated systems, was tasked by NETE to design an automated scanner that could incorporate various inspection heads and still meet the tight clearances. The scanner had to be versatile enough to inspect cylinders using different NDT methods from inside the cylinder.

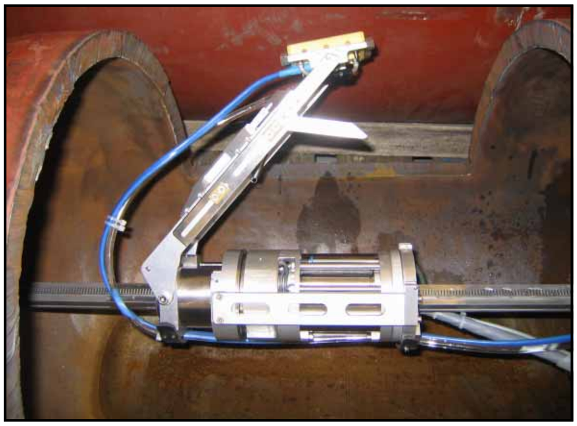

Fig. 2. A "rolling carriage" probe carries a scanner and other diagnostic tools inside a high-pressure cylinder that has been cut away to demonstrate the inspection rig.

The use of an existing scanner had been considered, but it would have required extensive redesign. The motorized, two-axis scanner that Olympus NDT ultimately designed especially for this application includes a flaw detection unit that can record data, and a C-scan display to facilitate interpretation (*Fig. 1*). The main challenge in designing the inspection equipment was the limited space available for the scanner in proportion to the cylinder's inspection surface. For set-up and insertion no part of the scanner could be longer than 30 cm, or exceed 10 cm in diameter. Considering the two axes of movement that are necessary for a proper raster scan of the inside surfaces, this proved to be challenging. Moreover, because submarine high-pressure cylinders come in various lengths and diameters, it was difficult to design a single instrument (to reduce cost and minimize set-up complexity) that could do the job.

Scanner Operation

The system is based on a rolling carriage design equipped with a probe-holding arm and a rail, supported at both ends of the cylinder. The probe arm folds back while the scanner is being inserted, then self-deploys. *Figure 2* shows the scanner with the arm deployed, mounted inside a cutaway cylinder. The arm rotates around the axis of the scanner, and moves along the rail. Alternating these two steps allows a complete scan of the cylinder's parallel surface.

The scanner operation can be broken down into three distinct functions: arm deployment, scanner translation, and rotation of the arm/probe system. Each function uses a dedicated device for operation — i.e., one motor for translation, one for rotation, and a double-acting air cylinder for arm deployment. The general layout of the scanner includes the carriage, which holds the three actuators as well as all the electronics, a rotating head in front of the main body, and a probe-support arm in front of the rotating head.

Smooth, effortless translation of the scanner is made possible by four casters which roll along a V-groove on each side of a rail. The casters are adjustable to eliminate side play. Operation of the translation motor is converted to movement by a rack-and-pinion system, and a limit switch mounted at the front of the scanner cuts all power to the motor once it detects an adjustable reference point mounted on the rail. A rotation motor drives the head of the scanner through a transmission. To limit overall rotation of the head, two Hall-Effect limit switches are mounted on the main body. The head itself has an overall rotation span of 400° to fully cover any overlap required for the inspection. A water coupling system for the ultrasonic inspections works in a closed circuit at 3.8 litres (1 gal.) per minute, with a centrifugal pump drawing from a catch tank and pumping to the probe head. This minimizes both water handling and spillage on board the submarine.

Inspection Procedure

To achieve repeatability and reliability during inspections, written procedures have been developed to establish standardized methods for performing inspections and for calibrating the inspection equipment. Cylinder reference blocks made from scrapped submarine cylinders have also been prepared as references to be used during inspections and to set flaw rejection levels. Since the reference blocks have to reflect the material and flaw characteristics that will be sought during inspection, electro-discharge machining (EDM) was used to create artificial flaws in the blocks.

The first step in the in situ inspection procedure involves the set-up, which allows a technician to safely assemble the inspection equipment inside a cylinder on board a submarine. Before this happens, however, access to the cylinder has to be established. The cylinder also has to be opened at both ends and cleared of loose debris, rust or any material that could affect inspection results. Co-operation between the shipyard and the inspection crew is vital. The inspection should then be performed as soon as possible to avoid the open cylinder from becoming contaminated. After the inspection, the cylinder should be cleaned and dried immediately to prevent surface corrosion or contamination from the coupling water used during the inspection, or from moisture in the air.

The second step of the inspection procedure is the calibration, which provides details regarding the reference blocks and the specific EDM notches cut into the blocks that will be used for the time base and reference level adjustments. The inspection procedure itself explains the inspection sequence, the rejection criteria and the reporting method that will be used. It also provides warnings, notes and other non-technical directives.

All of the automated inspection sequences are preset to speed up the inspection and ensure reliability of coverage. The sequences are standardized for repeatability. A scanning speed of 3.8 cm per second, with a

10-percent overlap was chosen to match the equipment's data acquisition capability and coupling efficiency while maintaining the minimum detection threshold. All inspection sequences use the same automated scanner. The selected sequence for each applicable method assigns the start/finish points and the travelling sequence for each scan.

The scanning sequence used in the parallel portion of the vessel starts by inserting the scanner into the cylinder and moving it to the far end. The steps to complete a full inspection cycle include scanning 365° clockwise, advancing the probe (allowing a 10-percent overlap), then scanning 365° counterclockwise. The parallel portion of the vessel is therefore completely covered, slice by slice. The scan data is then processed and displayed on a laptop computer screen using a combination of colour-coded A-scan and C-scan displays to help technical staff visualize the position of a defect and get a quick assessment of the flaw severity. The encoding system displayed on the screen locates an indication of a flaw on the cylinder wall, and permits analysis of the discontinuity for size, orientation and depth. *Figure 3* shows the result of an ultrasonic wall thickness inspection indicating a flaw on the exterior surface of the cylinder.

The automated manipulator is not designed to inspect the hemispheric areas of the cylinder. These are inspected manually using ultrasonic wall-thickness probes, and an eddy current procedure which uses variations in a magnetically induced electrical current to reveal flaws. This manual inspection provides a global overview of the surface conditions and completes the cylinder inspection.

The reporting procedure itself is relatively simple. The report identifies the cylinder and its location, and the detailed results of the in situ inspection regarding the characteristics of any flaws that were detected.

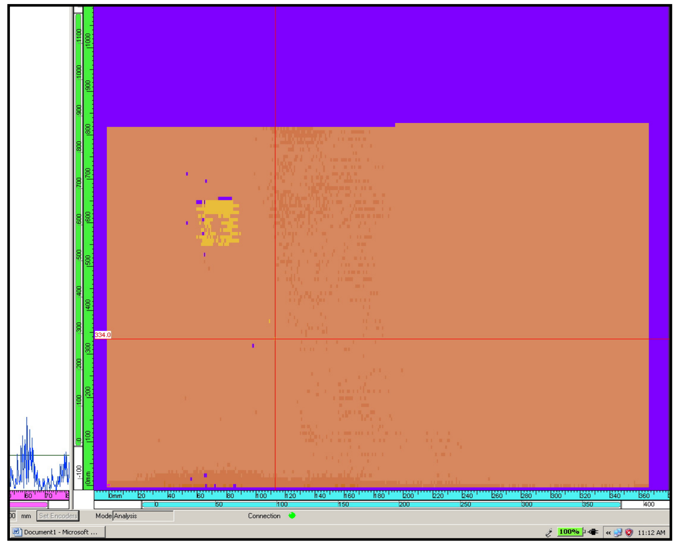

Fig. 3. Both the A-scan on the left and the C-scan on the right show a flaw area 40 cm² by 2 mm deep that was detected during a cylinder wall thickness inspection.

Implementation

A trial of the in situ inspection equipment and procedures was performed in a controlled environment at NETE during the summer of 2005. The inspection results were analyzed and compared to the known flaws in the cylinder. The few technical problems noted during this trial were rectified, thereby increasing the overall reliability of the inspection procedure. The next step before implementing this new procedure in the fleet will be an onboard trial designed to identify any potential anomalies remaining in the procedure. This trial is scheduled for summer 2006 with full implementation expected sometime this fall.

Conclusions

The main advantages of the described submarine HP cylinder recertification inspection method originate from its in situ nature. A great deal of money stands to be saved, and the risks of equipment damage and personal injury will also be greatly reduced. Downtime is kept to a minimum as no surrounding equipment has to be moved to clear a removal route. The integrity of the submarine's systems is also maintained since there is no need to dismantle them for cylinder removal purposes.

The repeatability and efficiency of this new procedure is very promising. The inspection results cover 100 percent of the cylinder's inner surface, compared to the 30-40 percent normally done because of the time constraints and manual labour involved. In this respect, the in situ method is clearly more reliable. The colour-coded inspection results are easily analyzed, and records may be kept on file for reference. The reliability of this inspection method is a good tool for long-term maintenance planning and risk assessment. Although this method was specifically developed for high-pressure cylinder inspection on board submarines, the tools and procedure could be adapted to other cylinder types. The overall process is considered to be a quantum leap in inspection efficiency and reliability.

Daniel Laplante is a non-destructive testing technologist in the facilities and technical support section of the Naval Engineering Test Establishment in LaSalle, Quebec. Stanley Lyczko is an engineer in the marine systems section of NETE. Retired Chief Petty Officer David Sankey is the DMSS 4-3-6 life-cycle material manager for shipboard compressed air systems in NDHQ Ottawa.

NETE News

Change of Command

Cmdre Richard Greenwood, DGMEPM, oversaw proceedings as Cdr Joel Parent (left) assumed command of the Naval Engineering Test Establishment on Friday, July 14. Cdr Parent has just completed the year-long Command and Staff Course at Canadian Forces College in Toronto, and takes over from Cdr Rob Hudson who moves on to the office of the Chief of Defence Intelligence at NDHQ. *(Photo by Brian McCullough)*

End of an Era

It is with great nostalgia, and yet a look to the future that the Naval Engineering Test Establishment in LaSalle, Quebec announces the end of its high-pressure steam capability. NETE was established in 1953 to support the production and development of high-speed precision steam turbines for the new *St-Laurent* class of fast, manoeuvrable destroyer escorts. Their specifications were in some respects so exacting that experienced industrial nations hesitated to proceed. Canadian industry accepted the challenge, and NETE has been supporting naval steam endeavours for more than 50 years. The navy has now moved away from steam-driven propulsion plants, so NETE is implementing a recapitalization plan which will align the facility to meet the evolving test and evaluations needs of the navy of tomorrow. As the famous saying goes, "All great things must come to an end." — **Cdr Rob Hudson**

NETE photo

National Defence Défense nationale

SUMMER 2006

News

CANADIAN NAVAL TECHNICAL HISTORY ASSOCIATION

CANDIB Project Key Activity for CNTHA

The major activity of the Canadian Naval Technical History Association continues to be the CANDIB historical research project. Thanks to some very energetic volunteers on our committee, the CANDIB project is making great progress in documenting the contribution of naval equipment and ship construction programs to the Canadian industrial base.

An acknowledged aim of CANDIB is to provide a focus for researchers. It has evolved to a data accumulation process, with the intention of making this information available to researchers of all stripes. In the past few months several new documents, artifacts and recordings have been submitted to the Directorate of History and Heritage (DHH). One such submission is a comprehensive document authored by **Jim Williams** that gives an in-depth look at the design houses of naval vessels since the development of the DDH-205 *St. Laurent* class.

In November, DHH archivist **Warren Sinclair** gave the committee a very pertinent presentation on copyright law and how it applies to CANDIB activities. It was noted that researchers are ultimately responsible for abiding by copyright restrictions in their endeavours. Donors of information to the DHH archive may put any restrictions they wish on the documents they provide.

As **Douglas Hearnshaw** writes elsewhere in this issue, the Oral History Project has recently emphasized the DDH-280 tribal class build program. Interviews were conducted with **VAdm (ret.) Jock Allan**, a former DDH-280 project manager, and with program engineer **Gord Smith**. Admiral Allan donated some highly interesting historical documents about this controversial program, and Gord has written a fascinating personal account of his experiences with the DDH-280 program.

CANDIB now has regional representation on the East and West coasts in the persons of **Roger Chiasson** and **Stirling Ross**, respectively. We are still looking for people who would like to volunteer as interviewers, and of course for people who would like to be interviewed. To give everyone a better idea of what we expect of our regional reps, and of the tasks relating to the Oral History Project, we have included our guidelines for these activities in this issue of *CNTHA News*.

The CANDIB committee has been actively getting the word of our mission out to the maritime community. The CNTHA/CANDIB website is very popular and the photo gallery receives many hits. The website at www.cntha.ca is continually updated with new information. Feel free to contact us if you care to discuss any aspect of the Canadian Naval Technical History Association's activities.

— Tony Thatcher
CANDIB Committee Chair

CNTHA News *Est. 1997*

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Update:

DDH-280 Tribal-class Destroyer Program Centre Stage for CANDIB Oral History Project

The beginning months of this year have seen the completion of two more interviews, both of them relating to the DDH-280 tribal program. The first was undertaken by **Gordon Smith** on Feb. 1 when he interviewed **Vice-admiral (ret.) Jock Allan**, the project manager for the contractual phase of the DDH-280 program. An informative discussion took place regarding the building and setting-to-work of the four ships at the St. Lawrence shipyards of Marine Industries Ltd. and Davie Shipbuilding Co. Ltd. At the time of this interview, Jock Allan donated to CANDIB his large collection of photographs and papers relating to the building of these ships.

The second interview took place on Feb. 27 when I had the pleasure of interviewing Gordon Smith himself. Gordon was closely involved with the DDH-280 program as a naval engineer developing the preliminary design for the vessels, including the choice of gas turbines for the propulsion equipment. Later, employed by German and Milne and working under a contract from United Aircraft of Canada, he acted as chief engineer during the sea trials and initial setting-to-work of the two MIL (Marine Industries Ltd.) ships. These two interviews add greatly to the growing recorded history of this significant naval shipbuilding program. As with all of our interviews, finalized transcripts will be placed on the CNTHA website for public viewing so that the world will get to read these interesting reminiscences.

There is still a need for additional knowledgeable people to undertake interviews for our Oral History Project. Anyone having either first-hand experience with, or solid historical background knowledge of government contracting processes or defence industry practices of the day is invited to contact me at (613) 824-7521, or by e-mail at dhearnshaw@trytel.com. We are particularly eager to hear from people who might be in a position to conduct interviews on the West Coast.

Vice-admiral (ret.) Jock Allan *(left)* being interviewed by Gordon Smith

— Douglas Hearnshaw
CANDIB Oral History Project Manager

CANDIB Oral History Project:

Criteria and Responsibilities for CANDIB Regional Representatives

Preamble

CANDIB is a national organization and seeks input from knowledgeable people throughout Canada. To date, limited travel expense funding has necessitated that all interviews under the CANDIB Oral History Project be held in the Ottawa region. It is apparent, however, that many opportunities exist for interviews with individuals residing on the East and West coasts and in other centres in Canada. It has therefore become necessary to consider ways in which these resources may best be explored. One obvious answer lies in establishing interviewing centres in regions other than the National Capital, and this in turn identifies the need for regional representatives. This document addresses the detailed requirements and practical aspects of operating a regional CANDIB centre, with particular regard to managing oral history interviews.

Criteria for Regional Representation

1. Regional representatives should be familiar with the aims of the CNTHA and CANDIB, and be prepared to explain them and solicit support for them from locally related organizations and personnel.
2. To promote CANDIB interests in their areas, regional representatives should have previously established connections with local naval organizations and/or possess a detailed knowledge of local industries that make up the defence industrial base.
3. CANDIB representatives should be familiar with, or at least show interest in such processes that involve research and gathering historical records, including preparing and organizing oral interviews.
4. It is essential that representatives establish a practical communication process such as e-mail so that messages can be exchanged quickly and efficiently with the CANDIB committee, and with the Oral History Project (OHP) manager in Ottawa in particular. Expeditiously exchanging written memos, guidance messages and other documentation is an essential aspect of the operation and cannot be achieved in any practical sense by telephone or surface mail.

Tasks Relating to Oral History Interviewing

1. Regional representatives must maintain open communication with the CANDIB committee and the OHP manager in so far as oral interviewing is involved. Representatives have a standing invitation to attend CANDIB committee meetings, and will receive minutes of these meetings.
2. Representatives will establish a list of potential interviewees in their regions. Following consultation with the OHP manager, a joint decision will be reached on proceeding with any particular interview.
3. Representatives must be familiar with, and follow the *Guidelines for Interviewers* issued by the CANDIB committee. Regional representatives must be prepared to plan interviews and carry out the necessary research regarding the background and related activities of all proposed interviewees so that representatives may ask meaningful questions and conduct effective interviews.
4. Regional representatives will be responsible for maintaining the recording equipment provided by CANDIB.
5. Representatives must be prepared to manage limited, pre-approved budgets for regional oral history projects. Budgets will require prior approval by the OHP before a representative commits to any interview.

Cleaning House?

The Canadian Naval Technical History Association is working hard at preserving Canada's naval technical heritage. If you are planning to dispose of any unclassified/declassified naval technical documents, drawings, videos, or other material you think might have historical significance, please contact Warren Sinclair, Acting Chief Archivist with the Directorate of History and Heritage in Ottawa. Arrangements will be made to examine your material, and steps will be taken to preserve whatever may be historically significant. Warren Sinclair can be contacted at (613) 998-7060. Thank you for doing your bit to preserve Canada's important naval technical historical record.