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Maritime Engineering Journal

75
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Canada's Naval Technical Forum

Fall 2014

Shipboard firefighting – The Royal Canadian Navy evaluates hand-activated aerosol extinguishers

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Canada

Something else the Navy was up to 70 years ago!

(Courtesy of the Canadian Football League)

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Maritime Engineering Journal

(Established 1982)
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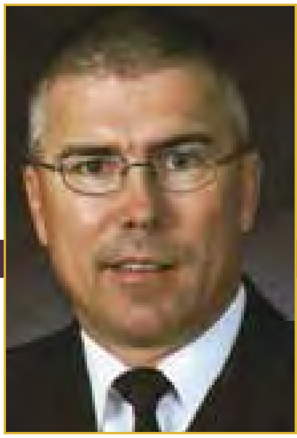

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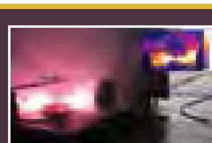

More than 50 live fire tests were conducted for the RCN's evaluation of hand-activated aerosol extinguishers at University of Waterloo.
Photo courtesy of LCdr Tom Sheehan

The *Journal* is available on line at the website of the Canadian Naval Technical History Association – www.cntha.ca

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Commodore's Corner

By Commodore Marcel Hallé, OMM, CD

Building our future by understanding our past – 75th edition and growing stronger

In May and August of this year the Royal Canadian Navy (RCN) and its technical community lost two legendary figures with the respective passings of Vice-Admiral (Ret.) Jock Allan and Rear-Admiral (Ret.) Denny Boyle. Both officers served at one point in their careers as Director General Maritime Engineering and Maintenance (DGMEM). Whereas RAdm Boyle went on to become Chief of Engineering and Maintenance in ADM(Mat) before retiring, VAdm Allan served as Commander of Maritime Command and retired as Deputy Chief of the Defence Staff. Both started as ordinary seamen and both would go on to become great naval officers and great engineers who inspired their generations and significantly shaped the course of our current navy.

In commemoration of his friend and colleague Denny Boyle, another iconic figure, Vice-Admiral (Ret.) Chuck Thomas, a former engineering officer who went on to serve as Commander of Maritime Command and Vice Chief of the Defence Staff, graced the naval engineering mess dinner in Esquimalt in October with his presence specifically to toast his former shipmate, chief engineer and friend. Having had the opportunity to speak with many of the junior engineering officers before the dinner, VAdm Thomas remarked with astonishment during his toast that few junior officers knew of Denny Boyle or, for that matter, of him. He then went on to question junior officers' awareness of their naval history. Those who attended the mess dinner received first-hand insight into VAdm Thomas' experiences and the leadership he provided in getting the Canadian Patrol Frigate and Tribal Class Update and Modernization Projects approved. For this alone, the RCN and Canadians in general owe him a great deal.

> *"There is a duty to learn from and impart what has been gained and we have an obligation as a profession to contribute to its body of knowledge. The* Maritime Engineering Journal *(MEJ) is but one important vehicle that does just that by helping to tell the story."*

In early October I had the honour of meeting with another of the RCN's iconic legends, Rear-Admiral (Ret.) Bill Christie, at his residence in Ottawa. Joining the Merchant Navy at 15 years of age, and being sunk in his vessel two years later, he joined the Royal Canadian Naval Voluntary Reserve in 1941 and eventually became an electrical officer in the RCN. Now 95, he is the oldest living individual to have served as an admiral in Canada's navy. A former Director General Maritime Equipment Program Management (DGMEPM) – back then it was Director General Maritime Systems – he would go on to become the first Chief of Engineering in ADM(Mat), and retire as the first Associate Assistant Deputy Minister (Materiel). I learned much that afternoon of the legacy he left, including his role in the design and construction of HMCS *Bonaventure* and his time as the project manager that delivered the *Oberon*-class submarines, two of his many significant contributions.

Admirals Allan, Boyle, Christie, and Thomas are but four of many iconic and legendary figures that have profoundly shaped today's RCN. In particular, their contributions to the advancement of the technical complexities that transformed the fleet from steam to gas turbine propulsion, evolving the principles in the practical application of increasingly complex project management, and the savvy leadership required to ensure naval programs successfully advanced within the bureaucratic complexities of Ottawa represent an amalgam of the tremendous accomplishments they have collectively achieved.

The RCN today faces many similar challenges as we continue to progress the modernization of the *Halifax*-class frigates, maintain steady state for the *Victoria*-class submarines, and deliver three new ship classes in the transition to future fleets. The same innovative approach, perseverance, passion and leadership exuded by these four individuals, and others that have gone before us, stand as examples of what must be done and what can be achieved. We need to continue to learn from what they experienced, particularizing it to today's environment. There is a duty to learn from and impart what has been gained and we have an obligation as a profession to contribute to its body of knowledge. The *Maritime Engineering Journal* (MEJ) is but one important vehicle that does just that by helping to tell the story. As we mark this, the 75th edition of the *Journal*, it offers a natural break point to pause and reflect on our navy's past and ponder the observation made by VAdm Thomas to those junior officers at the mess dinner that night in Esquimalt.

I felt it unnecessary in this edition of the Commodore's Corner to regale the *Journal's* origin, as my predecessors have so eloquently done in previous anniversary editions. However, I do specifically draw your attention to Commodore Dennis Reilley's comprehensive overview of the *Journal*'s beginnings in issue no. 28 – our 10th Anniversary issue released in October 1992. Canada's naval technical community has produced a jewel in the creation of the MEJ and owes a debt of gratitude and recognition to all who made it possible, in particular Commodore Ernie Ball, as it was under his watch as DGMEM that the first edition was produced. This combination of gratitude and recognition is also extended to the relentless efforts and passion of its Production Editor, Brian McCullough, and the support provided by his wife and long-time Associate Editor Bridget Madill. Brian has never missed a beat (other than when playing his tin whistle at mess dinners) as he has been with the *Journal* from its inception. Our thanks also go to the current Associate Editor Tom Douglas, and to d2k Marketing Communications for their work in producing such a superb professional journal. The contributions by the many that provided articles and participated in the various forums are also recognized, for without their input there would be no MEJ. A special note of thanks goes to the vast following of members who continue to include the MEJ as an important publication that adds to their body of knowledge and professional development. Lastly, a big Bravo Zulu goes to the Canadian Naval Technical History Association (CNTHA) that hosts the entire back catalogue of the MEJ on their website at **http://www.cntha.ca** to make it possible for the MEJ to reach a global audience.

As the director general fortunate enough to be marking this important milestone, I am immensely proud of what the *Maritime Engineering Journal* has accomplished. The MEJ has given an important voice to our naval engineering community over the past 32 years. As we mark its 75th edition, I encourage all of you to delve into past editions, learn from what has been written and be inspired to write. All are strongly encouraged to contribute their experiences to this forum so that current and future generations may come to know what transpired, ensuring this critical publication endures.

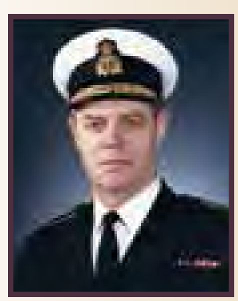
In memoriam

Canada's naval technical community regrets to announce the passing of two of the RCN's former chief engineers – Vice-Admiral John (Jock) Allan, 86, and Rear-Admiral Denis (Denny) Boyle, 79. Both men began their long-service naval careers as ordinary seamen and, in the words of the navy's current chief engineer, Commodore Marcel Hallé (DGMEPM), "both would go on to become great naval officers and great engineers who inspired their generations and significantly shaped the course of our current navy."

For notes regarding the service careers of these two fine officers, please visit: **http://nauticapedia.ca/Articles/Admirals_Canadian.php**

Courtesy of Paul and Sandra Dunn

Vice-Admiral John Allan, CMM, OStJ, CD
March 31, 1928 - May 1, 2014



Courtesy of Marcus Boyle

Rear-Admiral Denis Boyle, CMM, CD
April 10, 1935 - August 14, 2014

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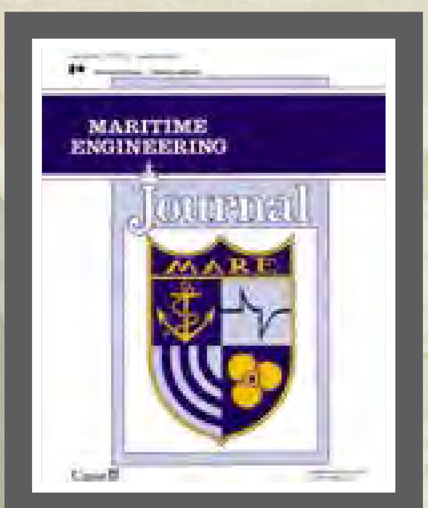
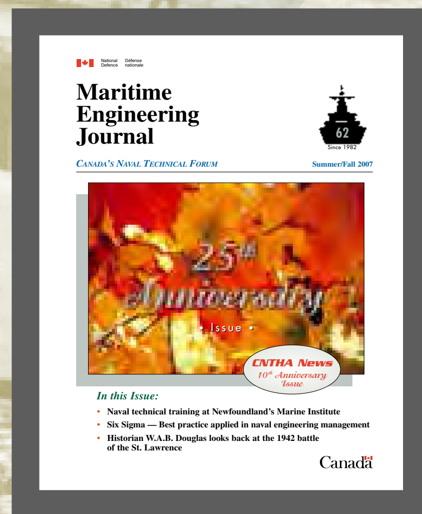


ENTY-FIVE
TAKES A LOOK BACK



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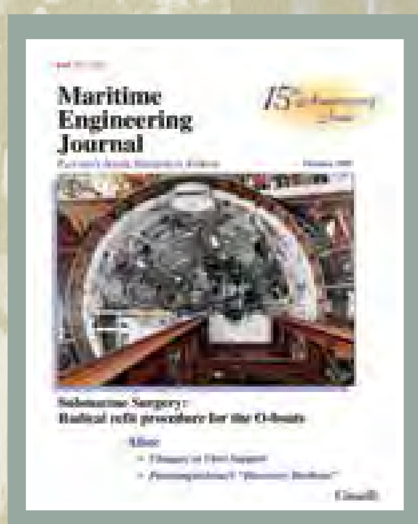


FORUM

A Wartime Radar Technician by Any Other Name

By LCdr Bill Dziadyk, RCN (Ret.)

While researching the provenance of a painting stolen from Ottawa's HMCS *Bytown* wardroom in 1979 (see MEJ 73), it was discovered that the Thomas Davidson painting *"Lady Hamilton's first sight of Lord Nelson"* had been donated to the navy in 1950 by the estate of James D. Good (VP of Supertest Petroleum in London, ON) to commemorate the wartime service of his son, RCNVR radar technician Petty Officer James (Jim) Reynolds Good.

Jim Good graduated from a year-long electronics and radio direction-finding course at the Radio College of Canada in Toronto before being enrolled into the Royal Canadian Naval Volunteer Reserve in November 1942. Because of wartime secrecy surrounding Canada's involvement with radar technology, his trade was recorded as "stoker first class" while he wore the trade and rank insignia of a *leading seaman telegrapher*. It was not until June 1943 that his personnel file would record him properly as a radar articifer, even though he and other members of his trade continued to wear the deceptive telegrapher's badge.

"Because of wartime secrecy surrounding Canada's involvement with radar technology, his trade was recorded as "stoker first class" while he wore the trade and rank insignia of a leading seaman telegrapher."

Courtesy of son Bill Good

Radar technician James Reynolds Good in 1942.
Note the telegrapher's trade badge on his right sleeve.

Petty Officer Good served as a radar articifer in the River-class destroyer HMCS *Qu'Appelle* (H69), and in 1944 completed the advanced radar and communications course at HMCS *St. Hyacinthe*, the RCN's wartime communications school located just outside Montreal. He died in 2011 at the age of 89.

Letters to the Editor

Dear Editor,

I would like to thank you, your production staff, and particularly author Bob Steeb, for the excellent feature article in the Summer 2014 issue of the *Maritime Engineering Journal*, describing the in-theatre repair of HMCS *Toronto*'s gas turbine propulsion system.

The technical content and illustrations covering the investigation, decision-making and repair processes are first class. BZ to Bob Steeb and the members of the team that achieved a successful repair in such challenging circumstances.

— **Gerry Lanigan, LCdr RN (Ret.)**
(MEO HMS *Antelope* 1979-81, prior to her demise in The Falklands Conflict 1982)

(Forwarded at the request of the editor...)

Hi Bob,

I don't think we've met, but I'm not letting that stop me from sending you a quick note to say how much I enjoyed your article, and how much I learned about *Halifax*-class GT propulsion and the challenge in HMCS *Toronto*. It's certainly one of the best (and easiest to follow) articles I've read. BZ and thank you.

Yours aye,

— **Cdr David Coffey, Capital Program Coordinator, Director of Naval Requirements, NDHQ Ottawa**

FEATURE ARTICLE

Royal Canadian Navy Evaluation of Hand-activated Aerosol Extinguishers

By LCdr Tom Sheehan
Photos and illustrations courtesy the author

Defence Research and Development Canada – Atlantic [DRDC(A)] and Director General Maritime Equipment Program Management [DGMEPM] recently conducted a joint research project on hand-activated aerosol fire extinguishers at the University of Waterloo. These small units are activated by hand, and tossed "grenade style" into spaces that are on fire. DRDC(A) is currently under a project arrangement with Sweden and Holland to investigate new or emerging fire suppression technologies. The goals include the identification of a safe and effective Halon 1301 replacement within the respective navies and the evaluation of all new commercial fire suppression technologies in a naval context. The subject area DRDC(A) agreed to study is aerosol fire-extinguishing agent technologies.

Concurrently, DGMEPM received a Statement of Operational Capability Deficiency (SOCD) from the Royal Canadian Navy (RCN) that identifies the need for an intermediary fire knockdown tool between the initial response of the Rapid Response Team (RRT) or the Rapid Attack Team (RAT) and the arrival of the full Attack Team (AT), a gap that can be several minutes of fire growth. Hand-activated aerosol extinguishers could potentially provide the capability the RCN is seeking, and an evaluation was required. To contribute to both the DRDC(A) and DGMEPM aims, full-scale live fire testing was conducted at the University of Waterloo (Uof W) Fire Research Lab on two variants of hand-activated aerosol extinguishers: the StatX *First Responder*® and DSPA *Manual Firefighter*® as shown in Figure 1.

Figure 1 – Full-scale live fire testing was conducted at the University of Waterloo's Fire Research Lab on these two variants of hand-activated aerosol extinguishers: the StatX *First Responder*® (left) and the DSPA *Manual Firefighter*®.

Background

There are several advantages to aerosol fire suppression agents. In the context of fitted systems, canisters can be easily installed and distributed to protect compartments of any size without the piping, nozzles, pumps, accumulators, foam proportioners, or compressed gas cylinders needed for many alternative suppression systems. As such, a pyrotechnic aerosol fire protection system is relatively simple and inexpensive to install as either a retrofit or in new construction. The canisters themselves have a shelf life of 10 to 15 years and periodic maintenance is normally only required on the activation signalling system. Aerosols are listed by the Environmental Protection Agency (EPA) as a safe alternative to Halons, with an ozone depletion index of zero and a greenhouse gas potential of zero. They show good potential as total flood suppression agents to protect machinery spaces and engine enclosures and are gaining popularity in marine, coast guard, naval and other industrial applications. There are, however, some concerns with pyrotechnically generated aerosols, including the heat and flames that are projected during initiation of the hand-activated versions, potential toxic gas production including oxides of nitrogen, carbon monoxide and even trace amounts of hydrogen cyanide, and the potential corrosiveness of the aerosol residue to sensitive electronic equipment.

Research Objectives

The primary objective of this research was to scientifically evaluate the fire suppression efficacy of the two variants of hand-activated pyrotechnic aerosol extinguishers against simulated marine fire scenarios. The objective was met by setting up and characterizing an instrumented single compartment fire experiment with fuel loading and ventilation parameters set to produce a consistent and repeatable fully developed fire environment. More than 50 live fire suppression tests were conducted to evaluate key suppression parameters such as upper gas layer cooling rate, impact on thermal stratification, and total compartment cooling effect. As a relatively new fire suppression technology for naval applications, there were several secondary research objectives for these hand-activated units, including aerosol particulate deposition on sensitive equipment (cold discharge), safe storage requirements, and incendiary potential. While the testing was designed to evaluate hand-activated aerosol extinguishers, the analysis, conclusions and recommendations pertain to the broader subject of pyrotechnically generated aerosol agents as a possible Halon 1301 replacement.

How Pyrotechnically Generated Aerosol Suppression Agents Work

The aerosol fire suppression agent is formed by the thermal decomposition of a hermetically sealed solid active compound consisting of an oxidizer, potassium nitrate (KNO_3), and a polymer fuel, phenol-formaldehyde, which also acts as a binder. It is essentially a solid rocket fuel (hence the need to quantify aspects of safe storage and incendiary potential). The resultant gas products of the thermal decomposition are potassium carbonate (K_2CO_3) that cools and condenses into micron sized solid particles, water vapour (H_2O), and carbon dioxide (CO_2) and nitrogen (N_2) inert gases. The potassium carbonate particles propelled from aerosol extinguishers normally have a mean diameter of 1 μm, which is small enough to remain suspended in air for up to an hour.

Condensed aerosols are primarily a chemical fire suppressant and, like Halon 1301 and other chemical fire suppressants, their efficacy depends on good distribution in an enclosed volume at the design concentration. While water, foam and inert gas suppression methods are fairly easy to visualize, chemical suppression agents take a bit more work to understand since the chemistry of fire is extremely complex.

When the potassium carbonate particles generated by the aerosol units are entrained in the flaming region of the fire they absorb energy, causing a decomposition that forms potassium free radicals, K+. These react with and interrupt the pool of hydroxyl, OH-, oxygen, O+, and hydrogen, H+, radicals that otherwise would be available to sustain the fuel-air reactions within the flame. Through the aerosol radical reactions, stable molecules such as potassium hydroxide (KOH) are formed and the fire is suppressed. This process of aerosol agent suppression is shown pictorially in Figure 2.

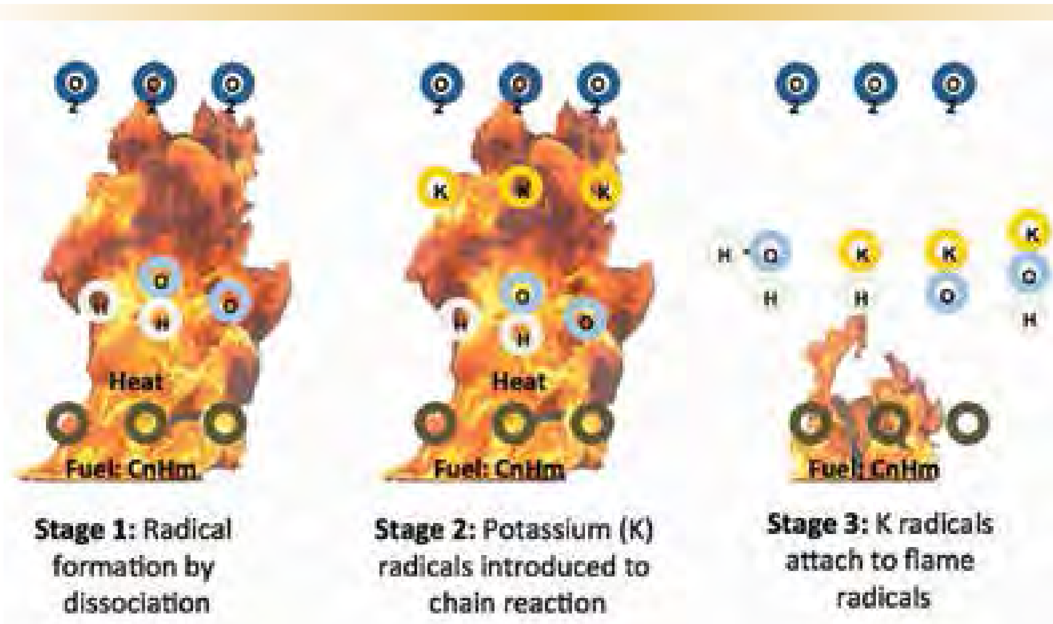


Figure 2 – Potassium carbonate particles generated by an aerosol extinguisher suppress a fire chemically by forming stable molecules such as potassium hydroxide (KOH) that interrupt the pool of hydroxyl, OH-, oxygen, O+, and hydrogen, H+ radicals that otherwise would be available to sustain the fuel-air reactions within the flame.

Full Scale Live Fire Suppression Testing

To determine the suppression efficacy of the hand-activated aerosol extinguishers and the aerosol agents themselves, four scenarios were developed to simulate realistic marine fires: an open diesel pool fire, an obstructed diesel pool fire to simulate a fire under an engine enclosure, an obstructed diesel bilge fire to test aerosol activation under water, and a softwood crib fire to represent accommodation spaces with large amounts of solid combustibles.

The fire compartment used to simulate a small marine machinery space or accommodation space at U of W was a modified 6.1m (20 ft) ISO shipping container. This enclosure is similar in dimension and thermal properties to a small emergency generator space onboard a marine vessel. The insulated burn room was instrumented to measure compartment internal and external gas temperatures, internal and external surface temperatures, heat flux, and gas concentrations.

In each scenario, the fires were allowed to grow to a fully developed or steady state (Figure 3), which represents the most challenging and most repeatable fire environment. A fully developed fire for this purpose was defined as an upper gas layer temperature of 600°C and a fairly steady mass transfer of gases in and out of the compartment. In order to understand the suppression effects on the fire due to aerosol agent alone, the ventilation in the compartment was not changed for some suppression tests once the units were activated. In preliminary tests it was discovered that closing the burn room door on a fully developed diesel fire can cause extinguishment by oxygen starvation alone. Therefore, combining aerosol activation with compartment confinement would have made it difficult to attribute suppression effects to aerosol agent vice oxygen starvation. Not changing the ventilation (i.e. leaving the compartment door open a set fraction) also allowed aerosols to be evaluated against fires in compartments breached by battle damage. For all tests, the suppression efficacy was assessed by measuring the upper gas layer cooling rates, integrating a value of total cooling effect on the entire compartment, and

Figure 3 – An insulated burn room constructed inside this ISO shipping container allowed for a good simulation of a fire in a small machinery space, and the measured effectiveness of a small aerosol extinguisher (shown) in that space.

by measuring the impact on thermal stratification (progression of temperature as a function of vertical height in the compartment) over the suppression period. Figure 4 is a summary of three open diesel fire tests where aerosol suppression alone is very comparable to suppression by oxygen starvation alone.

In general, the aerosol units performed very well against all fire scenarios. It was most interesting to show that aerosol agents perform very well in water under the diesel fires, which is promising for bilge scenarios. The results of the suppression testing allowed several key conclusions to be drawn that help to understand how aerosol agents work and how sometimes they do not work. When combined with compartment confinement the aerosol agents extinguished the fires quickly with up to a 30-percent to 40-percent better upper gas layer cooling rate and compartment cooling effect than oxygen starvation alone (closing the door). With the door left open a small fraction, however, the aerosol agent was easily overcome by the buoyant and turbulent fire gases. They were often carried out of the compartment before having any significant suppression effect. This was especially true for obstructed diesel fires.

As a primarily chemical fire suppressant, aerosols have little effect on a fire unless they are entrained in the flaming region. In a breached compartment scenario, consistent fire suppression similar to suppression by oxygen starvation could only be achieved when the aerosol agent was generated on the exact path of the cool air feeding the fire, which can be difficult to predict. Therefore, in addition to better understanding aerosol suppression, this testing reiterated the efficacy of proper fire confinement on its own, as oxygen starvation can rapidly suppress and even extinguish fully developed fires.

Quantifying Safe Storage Issues

In order to be effective on board as intermediate fire knockdown tools, these aerosol devices will need to be readily accessible; however, they are classed as pyrotechnic devices that would normally have to be held in floodable lockers on the upper decks. Therefore, it was important to conduct a series of tests to understand the consequence of a unit being accidentally activated inside its manufacturer supplied storage case. To achieve this goal, the cases were instrumented with thermocouples and set under a custom

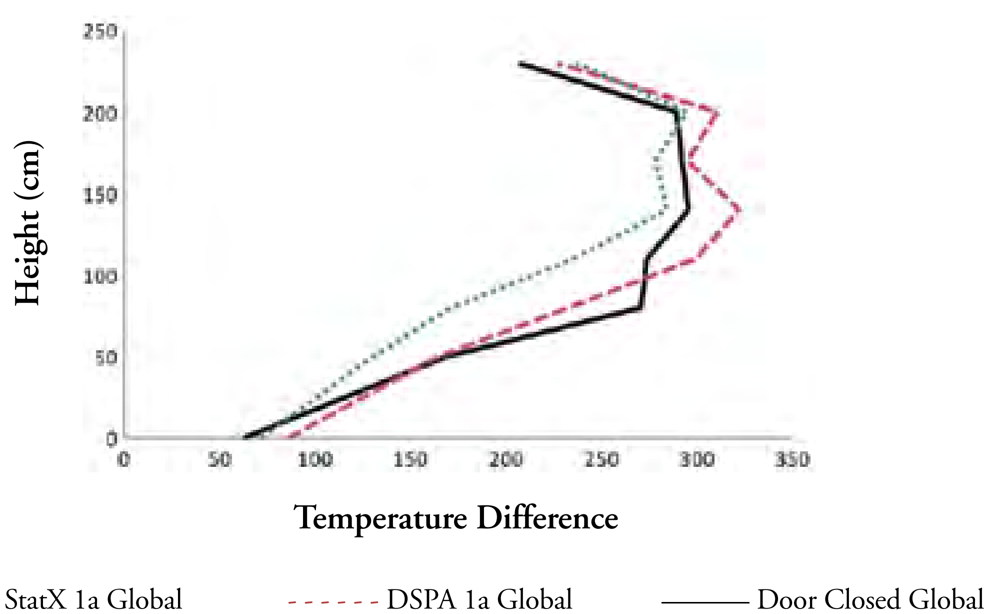


Figure 4 – This summary of the total compartment cooling effect during three open diesel fire tests shows that aerosol suppression alone by the two test units was comparable to suppression by oxygen starvation alone.

test rig to measure the radius of heat. Then, the aerosol extinguishers were initiated and the cases were closed. For both the DSPA and the StatX units, the cases held together well despite the internal temperatures reaching 800°C (Figure 5). The majority of the hot gases were expelled out the sides of the cases at 400°C. Very few hot gases were expelled at the hinges or clasps. Although this work did not assess the probability of such an event, understanding the consequence is a critical component to evaluating the risk of onboard storage and would feed into the design of safe storage racks and locations on board.

Quantifying the Incendiary Potential

Due to the heat and flame projection from these hand-activated aerosol extinguishers when they are initiated, the incendiary potential of the units needed to be assessed. The question was whether they could start a fire if used incorrectly. Additionally, the radius of heat and flames produced needed to be assessed in the context of safe use in proximity to casualties, fuel lines, and ammunition. Using a custom-built test rig, each unit was activated on a slab of polyurethane foam out in the open air, allowing the agent to dissipate. In both tests the StatX and DSPA unit ignited the foam slab and produced heat and flames above 100°C out to a 700-cm radius. This was a relative worst case scenario for incendiary potential; however, it highlights the significant thermal hazard. The units do produce an effective fire suppression agent but that agent can only mitigate the unit's own thermal hazard if it is confined to the area at the design concentration. This information will be essential to standard operating procedure (SOP) development for the various onboard scenarios in which they could be deployed.

Summary

This research challenged aerosol fire suppression agents against realistic naval fire scenarios in order to better understand their capabilities, limitations and potential hazards. In general, hand-activated aerosol extinguishers, when used correctly, have been shown to be very effective intermediate fire knockdown tools. The results and conclusions may be used to develop training standards, SOPs, and methods for safe storage onboard RCN warships. Additionally, these results support the assessment of aerosol agents as a potential Halon 1301 replacement that is safe to the environment, personnel, and equipment. Future work by DRDC(A) at the UofW Fire Research Lab on the potential toxicity and corrosivity of aerosol agents will further the collective knowledge of the technology greatly in terms of their use in occupied spaces and in compartments with sensitive and mission critical equipment.

Figure 5 – To test an accidental discharge of the aerosol extinguishers inside the manufacturer supplied storage cases, instrumented cases fitted with thermocouples were set under a custom test rig to measure the radius of heat after a unit was activated. For both the DSPA and the StatX unit (inset photos), the cases held together well despite internal temperatures reaching 800°C.

With all of this work, the RCN will know enough to be smart customers on aerosol suppression agents. Considering the time, money, and effort required to get to that point on one technology, a new appreciation for what is actually required to be a smart customer has also been gained.

The results of this testing have been shared with the fire safety community, as well as with Canada's naval allies, to aid all parties in the decision-making process for procurement and future use of aerosol suppression technology. There is a huge return on investment from our allies on such collaborative projects since most share the same challenge of being smart customers on a massive range of emerging technologies.

The UofW Masters of Engineering in Fire Safety is a program sponsored by DNPS 6. It is a requisite competency for the DNPS 6-2 position as the damage control and firefighting systems subject matter expert, and as the Fire Safety Certification Officer. The full-time program is approximately 18 months long and may be completed from a distance via live and interactive electronic classrooms. For more information about the program visit **http://mme.uwaterloo.ca/~firelab/Courses.html** or contact LCdr Tom Sheehan (**tom.sheehan@forces.gc.ca**).

Acknowledgment

The guidance of masters program supervisors Dr. Elizabeth Weckman and Mr. Gord Hitchman from the Department of Mechanical and Mechatronics Engineering at University of Waterloo, Ontario is gratefully acknowledged.

Reference

Royal Canadian Navy Evaluation of Handheld Aerosol Extinguishers, Masters Thesis (2013), LCdr Tom Sheehan, Master of Applied Science (Mechanical Engineering), University of Waterloo.

LCdr Tom Sheehan is the Damage Control, Firefighting and Seawater Systems Engineer in DGMEPM.

Submissions to the *Journal*

The *Journal* welcomes unclassified submissions in English or French. To avoid duplication of effort and ensure suitability of subject matter, contributors are asked to first contact the production editor. Contact information may be found on page 1. Letters are always welcome, but only signed correspondence will be considered for publication.

FEATURE ARTICLE

Defence Research and Development Canada Dockyard Lab Report: Non-skid Deck Coating Failure on HMCS *Glace Bay*

By Colin G. Cameron, Ph.D. Defence Scientist, Dockyard Laboratory (Atlantic)

Introduction

Canadian Fleet Atlantic Headquarters requested the assistance of Dockyard Laboratory (Atlantic) to investigate the failure of the non-skid deck coating on the foc'sle of the maritime coastal defence vessel HMCS *Glace Bay* (MM-701). The coating – a non-skid epoxy overlying an epoxy primer (each a two-part formulation) – was barely a year old when large patches began to lift off, exposing the steel deck beneath. The investigation failed to find any evidence of chemical deficiency or mechanical damage due to foot traffic and/or ice chipping, but it did show that the primer and topcoat had not been applied properly by a contractor.

Investigation

An on-site inspection confirmed the deterioration of the coating in at least three regions (Figure 1). The major damage was localized in patches of less than a metre square each. There was no apparent peripheral wear that could be attributed to high foot traffic, nor was the damage in locations that would immediately seem prone to such use; the nearby walkways were in good repair. The coating around the affected spots was still adhered to the steel deck plates, but could be easily pried up in large pieces with a small lab spatula. In other areas, small cracks and pinholes were stained with rust leaching out from the deck underneath. Samples of the coating were taken back to the laboratory for further examination.

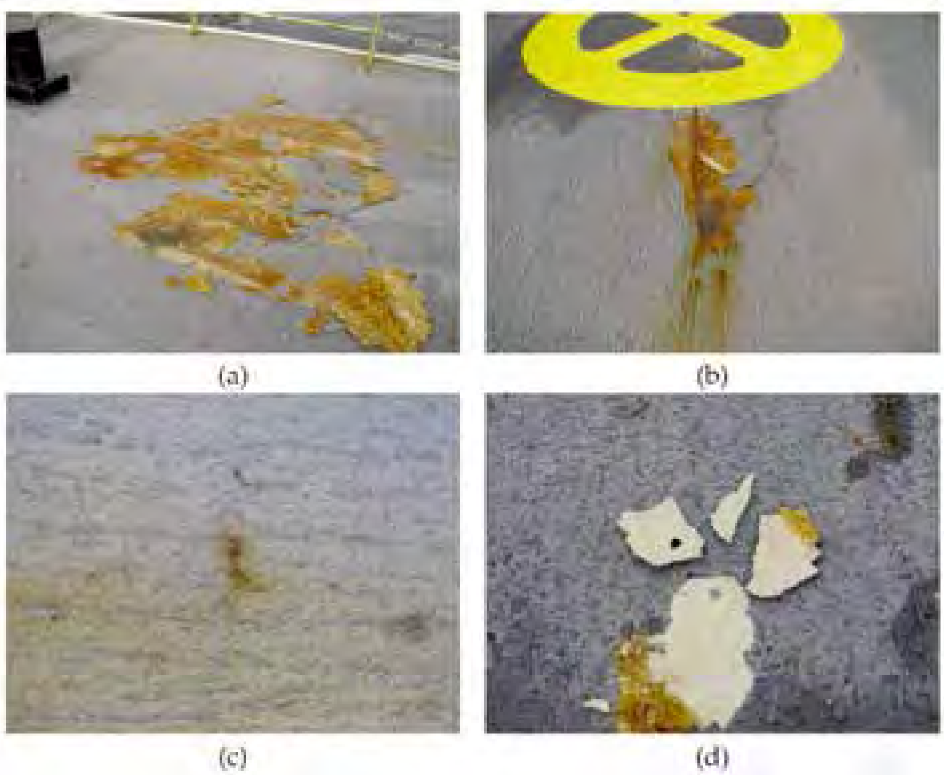


Figure 1 – Photographs of the foc'sle deck on HMCS *Glace Bay*: (a,b) two regions showing widespread coating lift-off, (c) one of many small cracks around 1 cm long found at random locations on the deck, and (d) flakes of coating that were easily pried off with a small spatula, revealing a pristine surface underneath.

A cursory microscopic inspection of the damaged coating did not reveal any surface features that would indicate mechanical damage, e.g., gouges from ice chippers or scratches from dragged equipment. There were, however, regions where mud cracking had occurred (Figure 2). This is evidence of shrinkage as the material cured, producing internal stresses that the material could not sustain. Fourier transform infrared spectroscopic analysis of the coating failed to reveal any chemical deficiencies, for example, amine blooming, that could be tied to a problem with the formulation of the product. Additionally, the batch numbers of the products that had been applied indicated that all were well within their recommended shelf life. Portions of topcoat were selected randomly, and mounted in cross-section for microscopic examination (Figure 3).

The specified thickness for the primer layer is 125-150 μm[1]. However, the microscopic survey revealed that the primer was much thinner, indicating that too little had been applied in the affected areas. So too had the non-skid topcoat. Specified by DND to be 750-1000 μm thick[1], the manufacturer notes that the surface profile should exhibit a uniformly rough appearance, with ridges 1.5-2.4 mm high, and no thinner than 760 μm (0.030") at the thinnest point[2]. It is clear in Figure 3 that neither complies with the specifications. In fact, in some places the combined coatings were so thin that light could shine through the pinholes.

The poor quality of the thin and irregular coat was exacerbated by air holes and voids, which can be clearly seen in Figure 3. While neither the DND directives[1] nor the manufacturer's guidelines[2] mentions voids, it is generally true that voids create weak spots in a material, and suggest deteriorated and/or improperly handled product. The inconsistent topcoat thickness could account for the mud cracks shown in Figure 2.

The application guide for the product[2] cautions that "thick, carelessly applied coats will result in minimum coverage and be subject to mud-cracking and/or blistering." This and the pinholes suggest both the topcoat and primer had indeed been "carelessly applied."

The daily inspection reports (DIRs) were obtained. These record a few weather details and the particular product being applied on a certain day, but not which part of the ship was being painted. A comparison of the weather observations against the historical data at a nearby Environment Canada meteorological station showed a good correlation, although the historical data did indicate precipitation had occurred within 24 hours of painting on six occasions. The DIRs also showed that the maximum allowed surface temperature of 40°C[3] was exceeded on at least three occasions, and the minimum difference between surface temperature and dew point was questionable on five. The DIRs also did not indicate that the dry thickness of the primer had ever been measured.

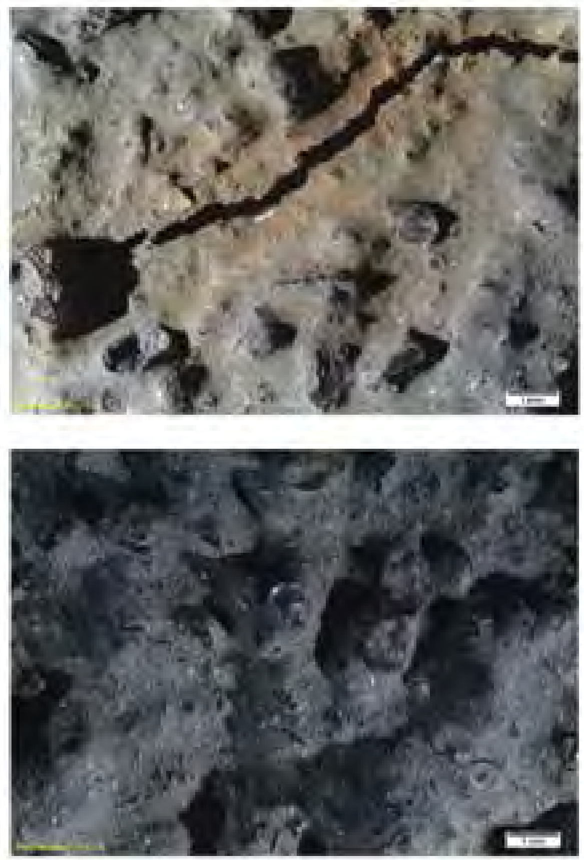


Figure 2 – Microscopic images of the surface of the deck coating. The cracks are consistent with the tearing-apart failure of a material that had shrunk and developed internal stresses. No signs of mechanical damage (i.e., gouges or tool marks) were detected.

1. (2009), Specification for Maintenance Painting of HMC Ships, Department of National Defence. D-23-003-005/SF-002.

2. (2012), Application Guidelines Exterior Deck System Intershield 6LV & Intershield 6GV, International / AkzoNobel. Revision 7.

3. (2012), Application Guidelines Cargo Holds Intershield 300, International /AkzoNobel. Revision 10.

Conclusions

In summary, there was no evidence of a problem with the formulation of either the primer or the non-skid topcoat, nor was there any indication of mechanical damage to the surface. While the daily inspection reports were rather lacking in detail, they do call into question the environmental conditions at the time that some of the coatings were applied.

More importantly, though, the microscopic survey of the coatings from the damaged areas did show quite convincingly that the primer and topcoat were not applied to the specified thicknesses. It was therefore reasonable to conclude that the failure was due entirely to poor application of the product by a contractor.

Acknowledgement

The author would like to acknowledge the assistance of his colleague, Nancy Herve, in this investigation.

Dr. Colin G. Cameron is a chemist with a background in electrochemistry and polymer science. He has been an employee of Defence Research and Development Canada – Atlantic since 2002, working in the Materials Identification and Analysis group at the Dockyard Laboratory (Atlantic) in Halifax. His areas of expertise include electrochemical energy storage, polymer actuators, non-metallic failure analysis, and fuels and lubrication chemistry.

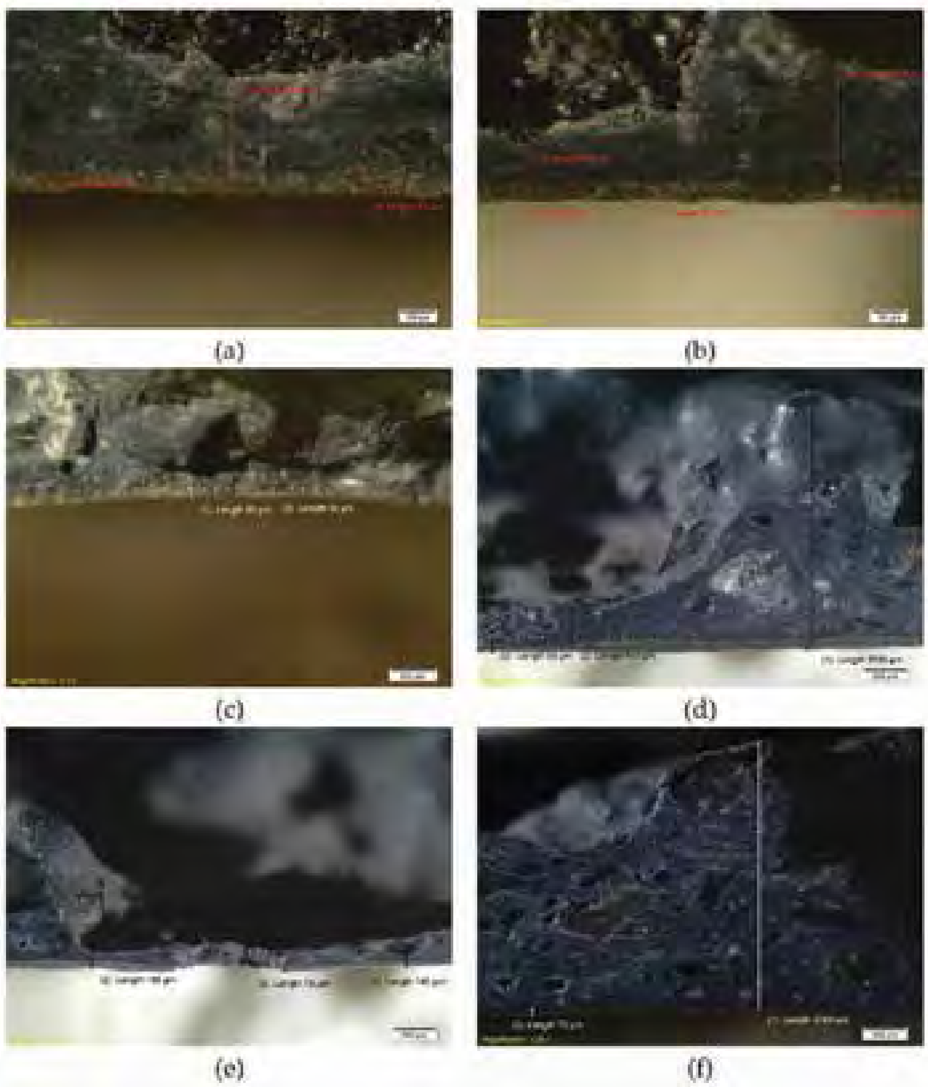
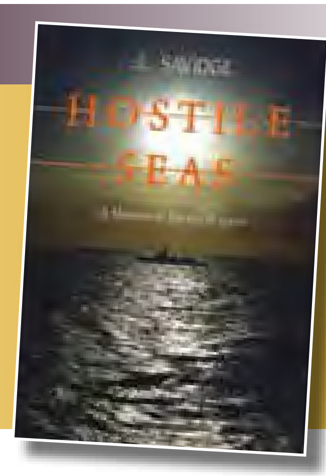


Figure 3 – Microscopic images of coating cross-sections. The thinner, silver-gold layer is the primer, while the thicker blue-grey layer is the topcoat.

Book Reviews

Hostile Seas

Reviewed by Tom Douglas



Hostile Seas – A Mission in Pirate Waters
JL Savidge © 2013
Dundurn (*www.dundurn.com*)
ISBN: 978-1-4597-1937-8 (pbk $22.99); 1939-2 (epub $11.99);
272 pages; illus.; bibliography and author's notes

While the title *Hostile Seas* is accurate in describing the setting for this book – the waters adjacent to the Horn of Africa where attacks by Somali pirates were frequent during the story's 2008 time frame – readers looking for swashbuckling action will not find it here.

Jennifer Savidge, a 33-year-old naval reservist at the time, spins an interesting tale of life aboard the *Halifax*-class frigate HMCS *Ville de Québec* when it was redirected from an exercise in the Mediterranean Sea to take up escort duty off the coast of Somalia. For several months, the ship performed the vital task of protecting pirate-menaced merchant vessels carrying food supplies to Mogadishu under the United Nations World Food Program.

The fact that the closest anyone aboard the *Ville de Québec* gets to Somali pirates during this account is when the ship's Sea King helicopter buzzes one of the high-speed craft used by the pirates, shooing them away from their intended target, could well be a statement on the effectiveness of the naval escort program.

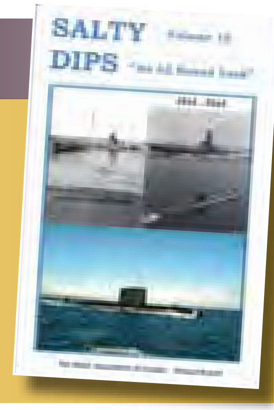
Serving as the ship's intelligence officer, Savidge – whose career alternates between shore jobs with Canadian charities and time at sea as a reservist – offers a fresh-coloured account of the daily routine on board a Canadian naval vessel engaged in potentially hostile operations. The author intersperses her narrative with a fictional account of a Somali youngster named Abdi who becomes a pirate in order to earn money to buy food for his fatherless family. But just like in the movies of old, this 'villain' pays dearly for his transgressions.

Hostile Seas is hardly a nail-biter, but an entertaining read nonetheless. Royalties from the book are being donated to VIDEA's Orphan and Vulnerable Children Education Program.

Tom Douglas is the associate editor of the Maritime Engineering Journal.

FROM THE PAST

Book Reviews (continued)



Salty Dips Volume 10 – The submarine edition!

Reviewed by Brian McCullough

Salty Dips Volume 10 *"An All Round Look"*

ISBN: 978-0-9784862-2-8 (pbk $15); 254 pages; illus.

The Ottawa Branch of the Naval Association of Canada has crafted the perfect close-out to the RCN's salute to the 2014 Canadian Submarine Service centenary. *Salty Dips Volume 10 – An All Round Look* (also available in ebook) is a special submarine edition of the popular *Salty Dips* anecdote series that holds a gold mine of entertaining and quirky stories from Canada's "silent service" between its covers.

In fact, there's even a story called "A Gold Mine?" – but be warned. Political correctness has been torpedoed in favour of preserving the narrators' original voices throughout the book. The perfectly clean foldout of submarine illustrations inside the back cover by Ottawa naval artist Karl Gagnon was a delightful surprise.

NCM Awards

Inaugural HMCS *Oakville* Award

Bravo Zulu to **Chief Petty Officer 2nd Class (CPO 2) Edward Burns** for receiving the inaugural HMCS *Oakville* Award, presented annually to the top Marine Engineer Certification 4 qualifying candidate.

Candidates for the award are selected, from both coasts, from all those who completed their Certification 4 qualification board during the previous year. The selection is based on their qualification board performance, their Technical Service Paper, Qualification Level (QL) 7 course academic performance and the recommendation of the candidate's commanding officer. The top two candidates are selected from a pool from each coast, completing a supplemental selection board to determine the ultimate award recipient.

This year's supplementary board was held on June 24, 2014 at the Canadian Forces Naval Engineering School (CFNES) in Halifax. The top two candidates were **CPO 2 Burns** and **PO 1 Vinny Prosper**, with CFNES Commandant, Commander Dave Benoit, acting as the board chair. Following a very close competition, Cdr Benoit presented the award to CPO 2 Burns, who is currently posted to CFNES Marine Systems Engineering Division.

HMCS *Oakville* was selected as the name of the award to recognize heroic RCN personnel from the Flower-class corvette HMCS *Oakville*, in particular Petty Officer (Stoker) A.J. Powell, who was instrumental in the sinking of the German submarine U-94 and the capture of 19 of its surviving crew in August 1942 off Haiti.

Courtesy RCN "Bravo Zulu" of the Week! – August 1, 2014

NCM Awards (continued)

Canadian Institute of Marine Engineering – 2013 T.M. Pallas Awards

Each year, the **T.M. Pallas Memorial Prize**, sponsored by the Canadian Institute of Marine Engineering (CIMarE), is awarded to outstanding non-commissioned engineering graduates of the Canadian Forces Naval Engineering School in Halifax, Nova Scotia. The instructors nominate the students receiving the highest combined occupation level course average and certification board mark while qualifying for their Marine Engineering Certificate 4 (Engineering Charge ticket) and Certificate 3 (Engineering Officer of the Watch).

Marine Engineering Coastal Advisor Chief Petty Officer First Class (CPO 1) Tom Lizotte (centre) presented the 2013 awards to (left) **Petty Officer First Class (PO 1) Edward Burns** for best Cert 4 and to **Petty Officer Second Class (PO 2) Charles Paulin** for best Cert 3. Both petty officers also received engraved plaques in commemoration of their academic excellence. Bravo Zulu!

Contributed by CPO 1 Pat Devenish, Canadian Fleet Atlantic Chief Engineer, Halifax

(Visit www.cimare.ca)

News Briefs

70th anniversary of thrilling "naval battle"

Not a shot was fired, but the Royal Canadian Navy won a decisive victory nevertheless 70 years ago on November 25, 1944.

The "battle" took place at Civic Stadium in Hamilton, Ontario where a pick-up team of sailors from HMCS *St. Hyacinthe* and HMCS *Donnacona* – the RCN Combines – actually took home the Grey Cup, defeating the favoured Hamilton Flying Wildcats 7-6 in the final minutes of play.

The rules for entry into the Canadian Rugby Football Union, which became the Canadian Football League in 1958, had been relaxed due to the fact that many professional players had signed up to fight in the Second World War.

Former HMCS *Donnacona* commanding officer Capt(N) (Ret.) Hugues Létourneau recalls: "*Donnacona* was allowed to borrow the Grey Cup for our unit's 50th anniversary celebration in 1993 after agreeing to safeguard the trophy and insure it for its three-day stay. Hotel and transportation costs for the person accompanying the Cup from Hamilton to Montreal were picked up thanks to the kindness of former Alouettes tight end/wide receiver Peter Dalla Riva who was inducted into the Canadian Football Hall of Fame that same year."

Go Navy!

— Tom Douglas

Courtesy of the Canadian Football Hall of Fame and Museum

The 1944 Grey Cup winners from HMCS *St. Hyacinthe* and HMCS *Donnacona* brought home two impressive pieces of hardware that year. The trophy on the right with the smaller handles was the team's ticket to the national championship game, signifying their supremacy in the Quebec Rugby Football Union regular season. On the left is the Grey Cup before the addition of a new, larger base.

News Briefs (continued)

First Regular Force chief engineer formally assigned to *Kingston*-class MCDV

Petty Officer First Class (PO 1) Scott D. MacPherson has joined Halifax-based HMCS *Goose Bay* (MM-707) to become the first Regular Force member of the RCN to be formally posted as Chief Engineer on board a *Kingston*-class maritime coastal defence vessel (MCDV). With the exception of a PO 2 ETech and MS WEng, the MCDVs are normally crewed entirely by Naval Reserve personnel.

This past spring a shortage of reserve sailors, and the reduced availability of seagoing frigate platforms for Regular Force crews due to the *Halifax*-class mid-life refit program, offered the navy an opportunity to solve the two problems at once. MCDVs on both coasts will now be crewed with a 60/40 Reserve/Regular Force split.

Shortages in the Naval Reserve's non-commissioned Marine Engineering Systems Operator (MESO) trade going back four years have given a small cadre of Regular Force engineers the opportunity to gain both experience and qualification endorsements in the MCDVs. On the West Coast, CPO 2 George Morris has already completed nearly six months of ad hoc chief engineer time in HMC ships *Edmonton* (MM-703) and *Saskatoon* (MM-709). PO 1 MacPherson, a Certificate 4 (Chief Engineer), required only a short "familiarization ride" before taking over as *Goose Bay*'s chief engineer.

PO 1 Scott MacPherson, who hails from the small Cape Breton fishing community of Alder Point, joined the Canadian Forces in 1989 and has logged more than 1800 days at sea. He was part of the first rotation for Op Apollo on board HMCS *Halifax* following 9/11, and deployed more recently aboard HMCS *Toronto* in early 2013 during Op Artemis for maritime security and counter-terrorism operations in the Arabian Sea.

Story and photo contributed by CPO 1 Pat Devenish, Canadian Fleet Atlantic Chief Engineer, Halifax.

PO1 Scott MacPherson

News Briefs (continued)

RCN's Arctic/Offshore Patrol Ships named *Harry DeWolf* class

Prime Minister Stephen Harper announced the name of the first of the Royal Canadian Navy's (RCN) Arctic/Offshore Patrol Ships (AOPS) on Sept. 19 in Hamilton, Ontario.

Her Majesty's Canadian Ship (HMCS) *Harry DeWolf* is named in honour of a wartime Canadian naval hero. HMCS *Harry DeWolf* is the first of the AOPS designed to better enable the RCN to exercise sovereignty in Canadian waters, including in the Arctic.

The AOPS will be known as the *Harry DeWolf* class, with HMCS *Harry DeWolf* as the lead ship. Subsequent ships in the class will be named to honour other prominent Canadian naval heroes who served their country with the highest distinction. This is the first time in its 104-year history that the RCN is naming a class of ships after a prominent Canadian naval figure.

A native of Bedford, Nova Scotia, Vice-Admiral Harry DeWolf (RCN) was decorated for outstanding service throughout his naval career, which included wartime command of HMCS *St. Laurent* from 1939-40, and later, his 1943-44 command of HMCS *Haida*, known as the "Fightingest Ship in the RCN." The announcement was made on board HMCS *Haida*, which now serves as a museum ship on the Hamilton waterfront.

RCN Photos

Vice-Admiral Harry George DeWolf, DSO, DSC, CBE, CD

RCN Photos

The AOPS will conduct sovereignty and surveillance operations in Canadian waters on all three coasts, including in the Arctic. The AOPS will also be used to support other units of the Canadian Armed Forces in the conduct of maritime-related operations and to support other government departments in carrying out their mandates, as required.

The AOPS will be built by Irving Shipbuilding Inc. in Halifax, Nova Scotia.

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Since 1982

Thank You!

25 YEARS AGO

The cover story for our January 1989 issue [No. 18] came to us from **Lt(N) Kevin Woodhouse** who was working as the *Improved St. Laurent* class officer at Naval Engineering Unit Atlantic. His intriguing and controversial story, ***The Saguenay Gearbox Mystery***, was a technical 'whatdunnit' of the first order. The sudden and perplexing appearance of a gearbox output (thrust) shaft oscillation in HMCS *Saguenay* two months after repairs were made to the ship's slightly damaged propeller following a gentle brush with a West German submarine in 1986 had everyone scratching their heads.

"The scant damage to the propeller blades had been completely deceiving," Woodhouse wrote. "The impact of the submarine fin on the propeller, although inflicting only minor damage to the blades, had transmitted a massive shock through the centre of the screw." The most popular theory, he said, was that the impact "caused the entire ship to bend."

There may have been no unanimity on the exact mechanical process that bent the shaft, but the brilliance of the *in situ* repair loses nothing in the reading almost three decades later.

In the same issue, Combat Systems Engineer **Cdr Roger Cyr** did a bit of crystal ball analysis in the area of machine-based decision-making with his article, ***Evolution of the Man/Machine Boundary in Combat Systems***.

"Significant technological advances have been realized in the way in which sensors and weapons are integrated," Cyr wrote. "This, it is believed, is the area that holds the greatest potential for technological advancement. The expert system of the future will result in command and control systems no longer requiring human intelligence or intervention for decision-making. The human himself, subject to the weaknesses of psychological and perceptual prejudice, exhaustion, stress, indecision and a limited, volatile memory, (is) the weak link."

Cyr went on to add that "technical innovations of immense proportion are now taking place in computer hardware and data-storage devices. Where the pre-TRUMP DDH-280 combat system memory space totalled some 250 kilobytes, that for the new frigates will total over 15 *megabytes*, or about 60 times as much."

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PRESERVING CANADA'S NAVAL TECHNICAL HERITAGE

CNTHA

NEWS

Canadian Naval Technical History Association

Former CANDIB Project Underpins CNTHA's Ongoing Mission

By Tony Thatcher

CNTHA News *Est. 1997*

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Views expressed are those of the writers and do not necessarily reflect official DND opinion or policy. The editor reserves the right to edit or reject any editorial material.
www.cntha.ca

The CNTHA's former Canadian Naval Defence Industrial Base (CANDIB) subcommittee was established in 2001 under the chairmanship of Rolfe Monteith to gather and document as much historical information as possible on Canadian naval construction programs, and the effect they had on Canadian industry. The CANDIB subcommittee was absorbed into the larger mandate of the CNTHA in 2008, but its original aim "to describe the development of the Canadian industrial base as it evolved in support of warship construction and naval equipment programs between 1930 and 2000" continues to be a significant driver underpinning the CNTHA's overall mission today.

When CANDIB entered into a contract with DND's Directorate of History and Heritage (DHH) in 2004 to run an oral history program (to be headed by Douglas Hearnshaw), the minor funding we received then and through to today has allowed us to produce nearly 50 taped and transcribed interviews made with key players involved in Canada's naval research, design, construction and engineering activity. These transcripts have been instrumental in helping DHH meet a key priority in writing Volume IV (1968-1990) of the official naval history, and are available through the Technical History section of the CNTHA website.

To date, the CNTHA's collection of oral history transcripts and other naval technical history material contains in excess of 500 items, including about 100 that specifically concern the naval industrial base. One of these is the late Jim Williams' 2005 *tour de force* study of the development of Canadian naval design capability from immediately after the Second World War, through the build of the DDE-205 *St. Laurent* class in the late 1950s and early sixties, to 2002 by which time it all had essentially dispersed. Another standout item is our 2004 interview with Tom Bennett, a member of the De Havilland engineering team that looked at the feasibility of designing the ocean-going naval hydrofoil that became HMCS *Bras d'Or* (FHE-400).

Rolfe Monteith was CANDIB's first chairman, and at age 91 continues to be an active and inspirational figure in the CNTHA.

The point of all of this effort, of course, is to capture the essence of Canada's naval technical experience as reference information for successive generations of engineers and researchers. Where else would one go to understand the challenges of switching from British-based equipment to American technology to meet the requirements for the Canadian-designed and built *St. Laurent* class? Or to learn how the knowledge gained from the Canadian Patrol Frigate program was used to upgrade Halifax Shipyard, thereby producing an excellent production learning curve for the later Maritime Coastal Defence Vessel project?

We at the CNTHA trust there will always be procedures in place to allow the RCN to preserve a clear picture of our technical history for future generations. On this note we are extremely grateful for the support offered to us by Cmdre Marcel Hallé, DGMEPM, both through his encouragement of our endeavours, and through his most generous offer of space in Canada's pre-eminent naval technical forum – the *Maritime Engineering Journal*.

The *Journal*'s 32-year publishing history is a testament to the value that the Royal Canadian Navy's technical branch places in remembering the lessons of the past as it manages the challenges of the day and anticipates the needs of the future. The CNTHA is proud to play a small, but we think important, role in this effort through our Oral History interview program on behalf of DHH, and by maintaining the complete back catalogue of the *Journal* on our website. We offer our thanks and congratulations to the *Maritime Engineering Journal* on achieving the remarkable milestone of Issue No. 75. *Bravo Zulu!*

Canada