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Canada

James Franklin Carruthers, CD, PhD, Captain(N) (RCN Ret'd) (1943-2021)

The Visionary Force behind the RCN's Fully Integrated Combat Data Systems

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Director General Maritime Equipment Program Management

Commodore Keith Coffen, CD

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HMCS *Charlottetown* on the Halifax Dockyard Syncrolift for rudder repairs. (Photo courtesy FMF Cape Scott)

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COMMODORE'S CORNER

Optimizing the NEM Enterprise through Dialogue and Understanding

By Commodore Keith Coffen, CD

CAF photos by S1 Callum Rutherford

Last summer's DGMEPM Change of Appointment ceremony saw RAdm Lou Carosielli relinquish the flag of office to incoming director general, Cmdre Keith Coffen (next page). The July 17, 2022 handover was officiated by MGen Nancy Tremblay, Chief Materiel Program.

Before I get to my main topic, I would first like to thank my predecessor, **RAdm Lou Carosielli**, for his two outstanding years of leadership as DGMEPM and Chief Engineer of the Royal Canadian Navy (RCN), and to wish him well in his new roles as Chief of Staff for the IM Group, Canadian Armed Forces (CAF) J6, and CAF Cyber Component Commander.

I would also like to thank you — the members of the Naval Engineering and Maintenance (NEM) enterprise — for the work that you do on behalf of all Canadians in support of the defence of Canada and North America. Your efforts have contributed to the preservation of a rules-based international order that has promoted prosperity, and prevented war on a global scale for more than three-quarters of a century.

Last year marked the 40th anniversary of the *Maritime Engineering Journal*, our own technical branch publication launched by **Cmdre Ernest Ball** (1932-1989) during his term as our director general. His 33 years of combined RCN/CAF service from 1951 to 1984 were exemplary, and taught him much about the importance of getting to the truth of a matter. As he noted in the very first Commodore's Corner in 1982, "It has been my experience that it is not what is true that causes problems, but rather what people think is true, but isn't."

Wise words indeed, so let me focus my first Commodore's Corner remarks (more than four decades later) by agreeing wholeheartedly with Cmdre Ball, and by reiterating the importance he placed on maintaining open dialogue and empathy in everything we do in support of the Royal Canadian Navy and the Canadian Armed Forces.

The NEM enterprise in Canada comprises thousands of people from across the Canadian Armed Forces, the Public Service of Canada, and Canadian industry who, together, are responsible for the effective stewardship of the significant public investment in the acquisition and in-service support of naval equipment. While no one component alone can accomplish the overall objective of delivering safe, ready, and relevant capability to the RCN and wider CAF, difficulty can arise when walls go up between, and sometimes within, the various components of the enterprise. This can lead to workplace "stove piping," whereby information moves easily up and down inside the work column, but not so easily into or out of it.

There is real danger in this type of functional isolation. Within a stove pipe, it can become significantly more difficult to understand the goals, challenges, and constraints of colleagues outside the walls, potentially leading to misalignment, miscommunication, misinterpretation, and mistrust. To avoid such outcomes, it is vital that all components of the enterprise work continuously to engage with one another; otherwise, the best we can ever hope to do is optimize within our own stove pipe. In his 1992 book, "The Goal," Israeli business guru Eliyahu M. Goldratt had it right when he noted that "a system of local optima is not an optimal system." Applying this to our situation, optimizing the NEM enterprise is a good thing, but only up to the point where further optimization begins to sub-optimize the overarching naval, CAF, or defence enterprises.

Consider, then, the following large-scale engagement initiatives that the NEM enterprise participates in to keep lines of communication open across the Canadian defence network:

- At the overall **Materiel Acquisition and Support level**, significant efforts have been undertaken in recent years to reduce the impact of stove piping through the creation of formal engagement opportunities. Just a few examples are the Deputy Minister-level Strategic Procurement Committee, Defence Procurement Secretariat governance committees, and the Major Crown Project Interdepartmental Oversight Committee, each of which links the defence team to other government departments involved in defence procurement.
- At the **Industry level**, the defence team engages through trade associations such as the Canadian Association of Defence and Security Industries, and sometimes through formalized meetings such as the Marine Industry Advisory Committee. For work under contract, there are also industry engagement meetings defined by the parties in the contract. A good example is the National Shipbuilding Strategy governance structure, which includes Executive Governance committees that link the most senior leadership in industry to senior leadership in government.
- Finally, at the **RCN level**, RCN governance helps overcome geographical stove piping, and links operators to engineers to logisticians. The NEM Management Board, and the Fleet Sustainment Oversight Committee are just two working examples of this.

It is important to remember that there are also a number of professional associations that do a great job of linking

across stove pipes. These include the Conference of Defence Associations Institute, the Canadian Global Affairs Institute, the Society of Naval Architects and Marine Engineers, the Canadian Institute of Marine Engineering, the provincial professional engineering societies, Engineers Canada, Technology Professionals Canada, and the Naval Association of Canada, among others. As professionals, we are all well-advised to take every opportunity to engage with these associations.

On a more personal level, I encourage everyone to connect with the widest possible cross-section of colleagues across the NEM enterprise, and really understand what it is they do: Navy to Materiel Group, Ottawa to the coasts, CAF to Public Service, DND to other government departments, government to industry. Curiosity and conversation are the keys to empathy, empathy is what makes for better understanding, and it is through better understanding that we can optimize the NEM enterprise.

In a new era of hybrid workplace structures, our success with this endeavour will depend heavily on our ability to maintain a common vision and sense of purpose across the enterprise. The longer we remain in a primarily remote posture, with limited in-person opportunities for professional dialogue and social connection, the more difficult it will be to achieve the degree of optimization our work demands of us. Our personal efforts in this regard have never been more important, and I look forward to exploring best practices with you as we chart a course into a new post-Covid domain. Our thoughtful reflection will inform the hybrid workplace of the future.

FORUM

In Their Own Words

During the 2022 MARLANT Naval Technical Seminar in Halifax, participants were asked to tell us about the most satisfying technical challenge of their career. As you can see from the short selection of responses presented here, what people chose to share describes an interesting perspective on life in the Royal Canadian Navy's technical branch. We plan to publish more of their submissions in our summer issue, but for now, enjoy this first offering of mini-essays in their own words:

Transition from NCM to WEng

The most technically satisfying challenge of my career to date has been my transition from NCM WEng Tech to CSEO NTO trainee. The level of knowledge I have acquired in the transition has been both humbling and exciting. The NCM world offered the thrill of immediate action and the challenge of a heavy technical and sailing schedule. The officer world looks to offer me the chance to influence the change I wanted to see as an NCM WEng.

— NCdt Mathew Lewis

[Note: The ranks alongside the names are as they were then.]

Technical diversity

The most satisfying aspect of my career is the technical diversity required to succeed as an NTO. From managing training system transformation projects, to tiered readiness support on *Halifax*- and *Kingston*-class vessels, to project support for the Canadian surface combatant, there are no "easy" projects — all are both challenging and interesting at the same time. Knowing that your efforts are meaningful and impactful to the RCN, the CAF, and ultimately Canadians, is a great motivator.

— Lt(N) John Couch

Establishing an operations and training framework

Most satisfying technical challenge in my career would be establishing the framework for operations and training on board the AOPV platforms. Being a part of the larger picture, and providing input today for the navy of tomorrow. I was fortunate enough to be a part of a once-in-a-quarter-century opportunity working with the AOPV project.

— CPO2 Patrick Gagnon

Photo by Brian McCullough

HMCS *Vancouver* (FFH-331) in 2005.

Storm causes damage to 57-mm gun

March 2006. HMCS *Vancouver* was sailing from Victoria to Pearl Harbor for a missilex, and encountered a severe Pacific storm, often submerging the fo'c'sle and 57-mm gun. On arrival in Hawaii, we found the gun had suffered internal damage that needed to be fixed before *Vancouver* could execute its missilex in three days. Through exceptional dedication and perseverance, the Combat Systems Engineering department completed all repairs, and declared the gun ready for the mission on time.

— Capt(N) Michel Thibault

Balancing university and family

I joined the Navy in 2009 as a WEng Tech. Long story short, I became QL5-qualified as a radar technician in 2015. In 2016/2017 I applied for UTP-NCM as a combat systems engineer and was accepted. By then I had a service spouse and three young boys (ages 7, 5 and 2 at the time). My biggest technical challenge in more than 12 years in the Navy was completing a four-year Bachelor of Electrical Engineering degree while trying to raise a healthy family. No regrets!

— A/Slt Scott McConnery

FORUM

Letter to the Editor

(Re: The 'invention' of the snorkel by Germany, from MEJ 96 Book Review)

While clarification may be found within the pages of the book under review — "Total Undersea War: The Evolutionary Role of the Snorkel in Dönitz's U-boat Fleet 1944-1945" — Germany's Kriegsmarine did not invent the snorkel (or 'snort mast' as we call it in our *Victoria*-class submarines), but instead was the first navy to start building boats for the express tactical purpose of remaining semi-submerged with diesel engines running.

Submarines of the Second World War could be considered more as submersible ships than true submarines, and out of necessity transited great distances while surfaced. (The ability to remain fully submerged indefinitely was later achieved with the advent of nuclear power and air-independent fuel systems.) This required hull valves and protected trunking to remain open to supply the diesel engines with air. Submerging was primarily a tactical requirement to avoid detection and escape engagement, and necessitated closing these large hull valves.

By the end of *Die Glücklichen Zeiten* — the first Happy Time (1940-1941) and second Happy Time (1942) as

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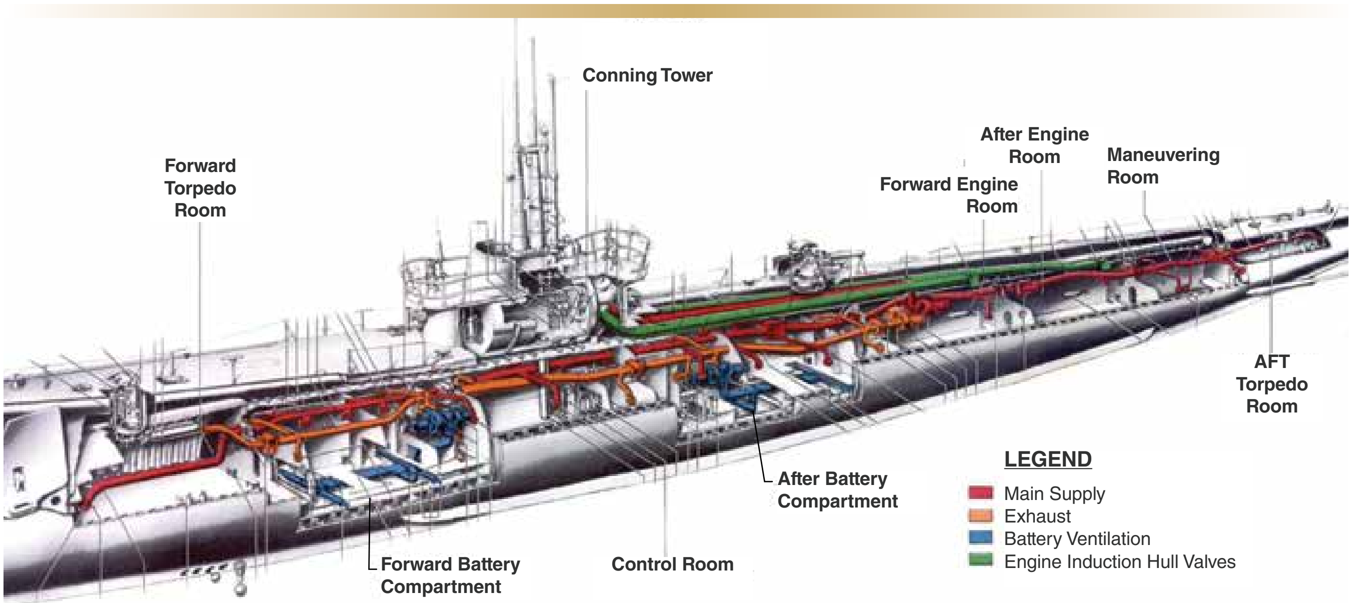
Courtesy Wikimedia.org

The surrendered Type-XXI U-3008 at Key West, Florida. The USN studied U-boat snorkel designs after the war for their own submarine programs.



Courtesy navsource.org

General arrangement of a USN *Balao*-class submarine, showing main air supply, exhaust, battery ventilation, and engine induction hull valve supply trunking.

they were known by German submarine commanders due to what was perceived as weak and disorganized defensive measures by the Allies — the U-boats were forced to spend more time fully submerged, unable to generate electricity to propel the boat and/or recharge the batteries. The advent of high-frequency direction finding and long-range patrol aircraft, had shrunk the relatively safe Mid-Atlantic gap in which the U-boats had previously had the freedom to run fully surfaced on their diesel engines.

Retrofitting a Dutch snorkel design that was discovered in two captured *O-21* class submarines in 1940 into the German Type VIIC and IXC-class U-boats, and its inclusion into the design of newer Type XXI U-boats (e.g. U-3008) and Type XXIIIs, might have started to swing the tactical advantage back in favour of Germany, but it was too little too late.

Interesting footnote: The United States Navy did not build submarines with snorkels until after the end of the war. One of the goals of the Greater Underwater Propulsion Power Program (GUPPY) was to install snorkel induction/exhaust conversions on fleet boats starting in 1947 (see *Balao*-class image). There were seven variants of GUPPY'd submarines, and while USS *Burrfish* (the future HMCS *Grilse* SS-71) did not receive a snorkel, USS *Argonaut* (the future HMCS *Rainbow* SS-75) did in 1952.

— JP Lang
Submarine Radar & Electronic Warfare, Ottawa
JohnPaul.Lang@forces.gc.ca

A note about our letter writer —

A self-professed long-time reader of the *Maritime Engineering Journal*, **JP Lang** is Senior Project Technologist for submarine optronics and masts with DMEPM(SM) at NDHQ Ottawa, and has 34 years of combined RCN and civilian service on naval technical systems. His interest in submarines, he says, was first piqued with a tour of the museum submarine USS *Bowfin* (SS-287) in Pearl Harbor during RIMPAC 90, and he continues to enjoy researching submarine history and technology, the Battle of the Atlantic, and the Pacific War.

JP Lang's proudest moment — receiving his dolphin qualification from HMCS *Windsor* CO LCdr Luc Cassivi while dived in 2006.

JP joined the RCN in 1988 toward the end of the Cold War, qualifying first as a Naval Electronic Sensor Operator, and then as a Naval Electronic Technician (Tactical). He began his career by listening for Soviet naval activity using specialized electronic intelligence (ELINT) and early warning gear, including one of the first installations of the AN/SLQ-501 Canadian Electronic Warfare System (CANEWS) aboard HMCS *Huron* (DDH-281). After completing his technician training at the Canadian Forces Naval Engineering School in Halifax, JP returned to the Pacific fleet to maintain radar systems in the modernized HMCS *Algonquin* (DDG-283), and in the frigates HMCS *Calgary* (FFG-335) and HMCS *Winnipeg* (FFG-338). He continued his involvement in electronic warfare by assisting with the first installation of the Condor Systems Sea Search passive electronic support measures (ESM) unit in *Winnipeg*, and then Sea Search II in the *Victoria*-class submarines.

For the last five years of his naval career, JP Lang served in submarines, retiring in 2009 as a petty officer second class. As a civilian, he went to work in the Radar/EW shop at Fleet Maintenance Facility Cape Breton for one year, followed by two years with Victoria Shipyards, and then six-and-a-half years with the Naval Engineering Test Establishment (NETE) for two of the *Victoria*-class submarine extended docking work periods. Last August, JP re-joined the Public Service in a position that brought him full-circle, as part of the team replacing Sea Search II, and as the life-cycle materiel manager (LCMM) for submarine radars.

HMCS *Rainbow* SS-75

FEATURE ARTICLE

FMF Cape Scott: Overcoming Challenges Associated with the Installation of HMCS *Charlottetown*'s Rudder System with a Focus on Rudder Hub Casting Defects

By LCdr Shane Kavanagh and A/SLt Marc Vézina

Throughout the operational cycle of the *Halifax*-class frigates, the ship's rudder is periodically inspected with the goal of confirming that its condition is satisfactory, and that it will operate within design intent. This inspection includes verification of the contact between the rudder vane actuator (RVA) and the rudder stock, and between the rudder hub casting and rudder stock, as well as an examination of the overall condition of all components. On occasion, defects are found which cannot be practically returned to original condition, but still allow the rudder to operate with minimal or no risk to equipment and personnel. In cases such as these, a Naval Defect notification is raised, and a risk assessment is conducted to identify any suboptimal conditions and document the risk.

During HMCS *Charlottetown*'s (FFH-339) most recent docking work period (DWP) at Irving Shipbuilding in Halifax, the contact fit between the RVA and rudder stock was found to be unsatisfactory. Following the ship's return to HMC Dockyard, the vessel was docked on the Syncrolift on January 31, 2022 to remove the steering system and make the necessary adjustments. At this time, it was discovered that the contact fit between the rudder hub casting and rudder stock was also below the requirement, and that there were also a significant number of defects within the rudder hub casting and securing wedges.

As HMCS *Windsor* (SSK-877) was scheduled to undock from inside the Syncrolift shed on May 29 (all dates mentioned are in 2022), it was determined that the work to rectify the steering system could not be completed in this window. A decision was taken to undock *Charlottetown* on April 18 without the steering system and rudder so that work could be progressed while *Windsor* was undocking. *Charlottetown* was subsequently redocked on June 16 for reinstallation of the repaired steering system, and thanks to an aggressive work schedule, the ship was returned to the fleet on July 14.

This article focuses on the defects within the rudder hub casting, the work to accept the remaining defects following the repair work carried out by Fleet Maintenance Facility Cape Scott (FMFCS) in HMC Dockyard Halifax, and how it relates to other *Halifax*-class vessels.

Rudder Hub Casting

Charlottetown's steering system, rudder stock, and rudder were removed to improve the contact fit between the RVA and rudder stock. Two wedges, which must be removed to separate the rudder from the rudder stock (Figure 1), pass through a keyway window in the rudder hub casting and the rudder post. During installation, these wedges force the rudder up onto the rudder stock, and ensure good contact between the rudder and rudder hub casting. It should be noted that the cover of the keyway window is welded in place, and smooth with the profile of the rudder. To access the wedges, this cover must be carefully cut free and removed.

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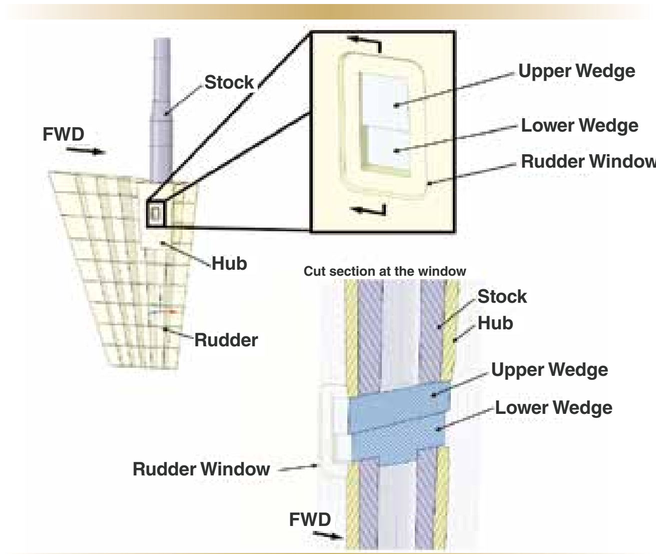

Image courtesy QETE

Figure 1. Excerpt from *Halifax*-class drawing SC8455639 – rudder arrangement and details.

The preferred method for removing the cover plate is to employ controlled air carbon arc gouging, making progressively light passes, followed by light grinding, to prevent damage to the rudder hub casting. However, there is evidence that in the past this has been done using a rotary saw or plasma torch — processes that offer far less control, and often damage the rudder hub casting. A quick survey of vessels under repair revealed that in-service rudder hub castings have a number of outstanding defects from such methods. While these unrepaired defects appear not to have had much impact on system performance, they represent stress risers, and should be repaired to minimize any risk to the steering system.

Initial Welding Procedure

The Royal Canadian Navy (RCN) is working with Lloyd's Register (LR) to enter the *Halifax*-class vessels into class, with *Charlottetown* currently under survey by LR for this purpose. The RCN does not need to comply with LR's repair recommendations, but their experience in ship repair cannot be ignored, and should be considered when developing repair plans. Initially, FMFCS developed a rudder weld repair independent of LR, as the job instruction incorporated experience from typical non-destructive testing (NDT) carried out on submarine castings, and similar weld repairs on anchor capstan drums that are manufactured to the same material standard as the rudder hub casting. The job instruction was reviewed by Directorate of Naval Platform Systems (DNPS) 2-4 and an outside subject matter expert (SME), recommendations were incorporated, and all agreed the procedure was suitable.

Figure 2. Port-side keyway window with cover plate removed to access the wedges. Gouges from the rotary saw are visible in the rudder hub casting.

Following LR's review, it was recommended that FMFCS work toward qualifying the weld procedure through the Procedure Qualification Record (PQR) process. This would take several months, and involve obtaining test material that meets the American Society for Testing and Materials (ASTM) A27 gr 70-40 standard, conducting test welds, and carrying out an NDT of the welded specimen to the appropriate standard. Furthermore, mechanical testing would be necessary prior to producing the final weld procedure. Given the short docking window available, completing the PQR was not an option.

Non-Destructive Evaluation (NDE)

Selecting the correct testing standards is a key requirement to assessing the material condition of any repair. Criteria that are too stringent can lead to rejecting equipment that is fit for purpose, while too lenient criteria can lead to accepting equipment that could fail in service. It is also important to recognize the original standards that were used during construction and initial acceptance. Normally, castings are inspected via magnetic particle inspection (MT) and radiographic inspection (RT). The *Halifax*-class rudder hub castings are constructed from ASTM A27, and their acceptance criteria included MT and RT — as was the case when the RCN acquired three spare rudders in 2015.

Lloyd's Register requested that ultrasonic inspection (UT) be included in our NDE of the rudder hub casting and associated repairs. At the time, as no specific UT standard was discussed, FMFCS defaulted to Canadian Standards Association (CSA) W59, chapter 12, for cyclically loaded structure. UT was subsequently conducted using both compression (0-deg) waves, and shear (70-deg) waves. Since CSA W59 is not an inspection standard normally used on castings, the results must be carefully analyzed and understood.

It should also be noted that UT is not usually conducted on castings; rather, RT is used to inspect for subsurface indications such as inclusions and porosity. However, FMFCS cannot conduct RT on the *Halifax*-class rudder hub casting due to its thickness. The radioactive source employed by FMFCS is simply not strong enough to penetrate such a large casting. The LR UT requirement refers to an ISO standard to which the rudder hub casting was not built to meet, and is not called for in any RCN requirements. However, FMFCS will evaluate this standard to determine if they are able to conduct such inspections in the future. It should be noted that a preliminary review of the LR standard indicates that only compression waves are to be used.

Port Keyway Window

Following *Charlottetown*'s 2019 DWP, FMFCS used a rotary saw to remove a portion of the keyway window cover plate to allow access to the wedges. Once the wedges were removed, and the rudder was removed from the rudder stock, the remaining portion of the cover plate was removed via air carbon arc gouging (Figure 2). When the cover plate was removed from the rudder's port side, however, it was noted that there were several gouges from the rotary saw in the rudder hub casting.

Courtesy Rodney Cole FMFCS NDT

Figure 3. Port keyway with defects excavated (April 27, 2022).

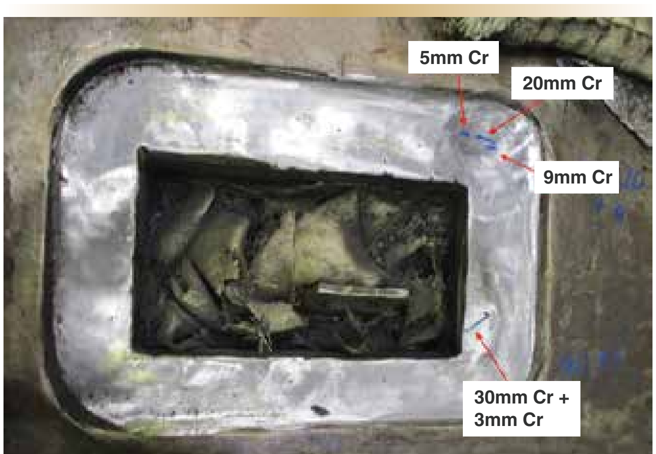

Figure 4a. Port keyway– MT defects discovered (May 6, 2022) following weld material build-up repair.

Through consolidation with Directorate Naval Platform Systems (DNPS) 2, Lloyd's Register, and external welding subject matter experts (SME), it was decided that the best course of action would be to conduct repairs to the rudder hub casting. The initial plan was to lay the rudder flat, gouge out the defect, and fill the cavity with weld material build-up (WMBU). Figure 3 depicts the port-side keyway window following excavation in preparation for the weld repair. It should be noted that three additional indications were found in the initial excavation and were removed prior to repair, these indications likely having been present within the parent material since the time of casting.

Pre-heating with torches was employed as part of the welding process to prevent cracking. As soon as the initial weld repair was completed, hot magnetic particle inspection (MT) was conducted on April 28, and found no issues at the weld surface. However, following the 72-hour cool-down period, and after the welds were ground flush, MT discovered several defects (Figure 4a). LR requested that UT be conducted on the weld repair, which FMFCS conducted using CSA W59 requirements. Although no defects were found using compression waves, shear waves discovered several areas of defect (Figure 4b), which were excavated (Figure 4c), and repair was attempted once again on May 10. Hot MT conducted the same day found no indications, but subsequent MT on May 13 following cool-down and grinding revealed 19 minor indications in the surface. It is interesting to note that these were generally not within the weld repair. LR requested UT be conducted on the weld repair using CSA W59. Although no defects were found using compression waves, shear waves once again discovered several areas of defects.

(Continues next page...)

Figure 4b. Port keyway– UT defects (May 6, 2022).

Courtesy Andrea Colbourne FMFCS NDT

Figure 4c. Port keyway – second defect excavation (May 9, 2022).

In an effort to meet the compressed undocking schedule, FMFCS decided to progress other production work while the engineering team explored repair options for the defects in the rudder hub casting at the keyway windows. No additional repairs would be attempted on the port keyway window until the rudder was returned to a vertical position. With the rudder held in the jig (Figure 5), FMFCS Production and Mechanical Engineering teams could progress the contact fit work between the inner bore of the rudder hub casting and the rudder stock. Before doing this, the rudder was flipped to gain access to the starboard keyway window. As historical repairs were not usually recorded in detail, nor had any NDE been conducted prior to the repairs discussed in this article, there was no baseline for determining the initial condition of the rudder hub casting. It was hoped that an examination of the starboard-side keyway window might offer some clues to the casting's initial condition.

Starboard Keyway Window

Once the rudder was flipped, the remaining portion of the cover plate was removed using air carbon arc gouging. It was immediately apparent that the starboard-side casting had been damaged in the past when removing the cover plate (Figure 6), and that the ship had clearly been in service with these defects for a number of years.

MT and UT conducted on May 19 revealed a number of indications. All indications found through UT utilized a shear wave; none was found using the compression wave. Rather than attempt a weld repair, it was decided that

Figure 5. *Charlottetown*'s rudder upright in the jig.

Figure 6. Starboard-side keyway window – pre-existing defects caused by a rotary saw and plasma torch, discovered May 19, 2022.

additional information was needed so as not to repeat the unfavourable results experienced while repairing the port-side keyway.

Following the results of the second weld repair attempt, the FMF Naval Architecture Officer (NAO) engaged

DNPS 2, LR, and an external welding SME to understand why these defects were appearing. As the rudder hub casting is nearly 30 years old, and the associated ASTM standard had changed from the time of casting, there was concern that these defects were a result of impurities (such as sulphur) in the parent material. Defence Research and Development Canada Atlantic (DRDC(A)) was requested to conduct a chemical analysis, and provide input.

Three samples analyzed from the starboard keyway window confirmed that the pre-heating was satisfactory to prevent cracking in the heat affected zone for the calculated carbon equivalent. The samples were generally within the ASTM A27 standard, although sample one was high in carbon content, and samples two and three were high in sulphur. DRDC(A) calculated the units of crack susceptibility (UCS) in accordance with American Society for Metals International procedures to estimate the effect of various content levels of sulphur, phosphorus, and other elements. Where a UCS figure above 30 is considered to be highly susceptible to cracking during welding, our three samples were found to have UCS readings of 61, 53, and 43, respectively.

Photo courtesy NDQAR Detachment Halifax

Figure 7. *Ville de Québec*'s rudder keyway window – May 19, 2022.

To get some idea of how ubiquitous this issue might be throughout the fleet, the NAO contacted National Defence Quality Assurance Region (NDQAR) detachments inside shipyards that conduct *Halifax*-class DWPs. All of them reported that defects to rudder hub castings from rotary saw cuts are common (Figure 7). While it is not ideal to have such defects throughout *Halifax*-class vessels, there is some level of confidence in knowing that they seem to present low risk to vessel operation. Following the results of the chemical analysis, and the experience gained during the previous repair attempts, discussions turned to possibly accepting these defects, and returning the rudder hub casting to service. At this point, the rudder was returned to the vertical position in its jig. Any repairs to the starboard keyway window would be made with the rudder in the jig.

Rudder Stock Contact Fit Improvement

Following *Charlottetown*'s return to HMC Dockyard Halifax on June 16, the vessel was docked to remove the steering system, and improve the contact fit between the RVA and rudder stock. At this time, it was discovered that the contact fit between the rudder hub casting and the rudder stock was also below the requirement. The process of improving the contact fit is quite tedious, and requires that the rudder stock be mated/unmated with the RVA/rudder upward of 100 times. After each contact fit the FMFCS production team had to meticulously remove small amounts of material from high points on the mating surfaces. (Figure 5 depicts the rudder stock being lowered into the rudder hub casting while the rudder is secured in the vertical jig.)

Temporary Rudder Hub Casting Repair

Although this article focuses on the technical issues surrounding the rudder hub casting, it does not elaborate on the challenges associated with preparing the RVA, rudder carrier bearing, and jump ring, nor on the many other complex, interdependent tasks required to ensure the modified rudder stock would integrate seamlessly with the steering system. When the contact fitting between the rudder hub casting and rudder stock was completed, the preparations inside the ship were not, offering a short window for temporary repairs on the keyway windows.

At this point in the program, conducting another weld repair presented a significant risk of introducing additional indications, such as surface breaking fractures. These

(Continues next page...)

indications represent areas of crack initiation, and should be removed. Furthermore, sharp changes in the surface profile represent stress risers and should also be removed. Following discussions with DNPS 2 and LR, it was decided that any defects would be ground out of the parent material, and confirmed as removed via MT. This temporary repair is recorded in Defence Resource Management Information System (DRMIS), and a Naval Defect notification has been raised with the intention to inspect the keyway windows at the next docking, either during the ship's interim docking, or any unscheduled docking. Figure 8 shows the temporary repair on *Charlottetown*'s rudder. The same repair was also selected for the keyway window repairs on HMCS *Ville de Quebec* (FFH-332) during that ship's recent DWP.

Securing Wedge Modification and Installation

Once the rudder stock was installed in the vessel, and the repairs to the rudder hub casting were complete, installing the securing wedges came next. The securing wedges force the internal bore of the rudder hub casting up onto the lower taper of the rudder post to ensure good contact between the two mating surfaces, and it is through this contact that the torque is transmitted between the rudder and rudder stock. A significant amount of material had to be removed to improve the area of contact, which resulted in the rudder moving vertically more than it typically would during installation of the wedges. While adjustments were made to the internal components to account for this, the stock securing wedges were no longer deep enough to force the rudder fully into position. As there was insufficient schedule to acquire new wedges that would fit, FMFCS Mechanical Engineering and NAO decided the best course of action would be to modify a set of stock wedges from stores.

The plan was to manufacture shims, using the remains of the original wedges that were removed from *Charlottetown*, and weld them onto the new wedges (Figure 9). Once again FMFCS found itself with a need to weld a component that was suspectable to cracking, and with only one set of securing wedges available in the supply system there was little room for error. NAO, DNPS 2, and an external welding SME developed a welding procedure, and conducted a test weld with portions of the old securing wedges. NDE on the welds revealed several indications, but as the securing wedges are primarily loaded in compression there was little concern these would impact the performance of the rudder. As with the remaining defects in the keyway windows, a Naval Defect notification was raised in

Figure 8. *Charlottetown*'s temporary keyway window repair with defects removed.

Figure 9. *Charlottetown* rudder lower securing wedge with shims installed.

DRMIS so that the wedges will be inspected during the next DWP. With the shimmed wedges machined to the correct thickness, the rudder was fitted to the rudder stock, and the securing wedges were installed and welded into position. The ship was ready to be returned to service.

There were no details on the rudder arrangement drawings regarding the weld required to fix the securing wedges together, so it was clear through discussions between NAO and NDQAR staffs that bespoke welding instructions would be required. NAO worked with DNPS 2 and an external welding SME to develop instructions from this final weld, and a plan to conduct an appropriate test weld to simulate the conditions that would be experienced when conducting the final weld. Once the securing wedges are installed, the entire rudder hub casting and rudder act as a heat sink which makes it difficult to ensure a correct pre-heat and controlled cool-down (Figure 10). During the test weld, the test pieces were surrounded by thick scrap metal to act as a heat sink. Furthermore, as would be the case during installation, the pre-heating and cool-down were controlled by applying heat to one side of the test piece. Once the test weld successfully passed NDE, the securing wedges were installed and welded together.

Conclusion

Following *Charlottetown*'s 2019 DWP, FMF Cape Scott worked under a tight schedule to remove the vessel's steering system, and improve the contact fit between the RVA and rudder stock, and between the rudder hub casting and rudder stock. A number of defects were found within the rudder hub casting in the keyway window area, due generally as a result of historical practices during removal of the access cover to the securing wedges.

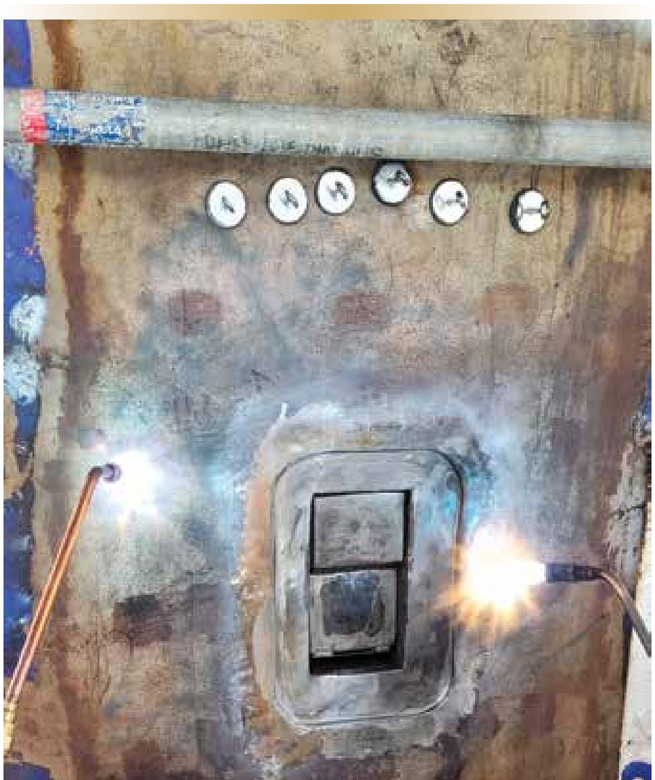

Figure 10. Pre-heating *Charlottetown*'s rudder hub casting prior to welding the securing wedges in place.

Figure 11. *Charlottetown* rudder installation.

Following a number of setbacks during the repair process, it became clear that the chemical composition of the rudder hub casting and securing wedges did not readily lend itself to weld repairs, and that defect mitigation must be considered. The defects discovered within the rudder hub casting were removed via grinding, while the defects within the securing wedges were accepted following an assessment of the loading and possible failure mechanisms during operation.

The outstanding defects discussed in this article have been captured in DRMIS, and a Naval Defect notification was raised to inspect these components for signs of further deterioration during the next docking period. Meeting the schedule discussed here was difficult, but the FMFCS Production team was able to meet its targets (Figure 11) despite a number of significant challenges, including the requirement to complete several docking evolutions throughout the repair. The engineering and guidance required a tremendous team effort, and included input from FMFCS NAO, Mechanical Engineering, NDT, Fleet Technical Authority, DNPS 2, Major Surface Combatant, DRDC(A), and Lloyd's Register.

LCdr Shane Kavanagh is the Naval Architecture Officer at FMFCS in Halifax, NS. A/SLt Marc Vézina was an Additive Manufacturing project officer at FMFCS, and is currently a student at the Naval Fleet School (Atlantic).

FEATURE ARTICLE

Internal Communications Trunked Radio System (ICTRS) for the *Halifax*-class Frigates

By Algis Jurenas

The Internal Communications System (ICS) of the RCN's *Halifax*-class frigates has been upgraded with an Internal Communications Trunked Radio System (ICTRS) that provides hands-free communications tied directly into the wired ICS Shipboard Integrated Communications (SHINCOM) network. It is a circuit-switched, non-IP system that is resilient to hacking.

The ICTRS requirement grew out of a Board of Inquiry (BOI) investigation of a gas-turbine fire aboard HMCS *Ottawa* (FFH-341), and in response to a Statement of Operational Capability Deficiency (SOCD) relating to the 50-calibre machine-gun positions on the *Halifax*-class frigates. In the first instance, the BOI found that the PRC transceivers used for damage control (DC) had inadequate coverage and required manual push-to-talk, thereby endangering the firefighters. With the 50-cal. SOCD, the communication setup of a tethered SHINCOM terminal and wired headset was considered cumbersome, and a source of delay during evolutions.

The Directorate of Naval Requirements subsequently stood up a requirement for a hands-free wireless communication system (later renamed the ICTRS) as part of the Frigate Life Extension (FELEX) ICS upgrade project. The ICTRS was to have:

- Two operational profiles:
    1. Mission critical for part ship and damage control (PSDC), 50-cal. gun positions (and now, manual operation of the Multi-Role Weapon System), and the helicopter (and upcoming UAV) flight deck;
    2. Non-mission critical "person on the move" mobile for roundspersons, officer of the watch, and maintenance tasks;
- Connection to SHINCOM with the same reliability; and
- 95-percent coverage of crewed areas.

Developing a solution

We began by examining the current state-of-the-art technologies. MACOM Technology Solutions of Lowell, Massachusetts gave a presentation to the RCN on the USN Hydra system, whose main features were (a) a narrowband FM trunked LMR (land mobile radio) system; (b) a passive distributed antenna system (DAS) utilizing radiating transmission line (RTL – also known as 'leaky coax'); (c) a split repeater and RTL; (d) discrete antennas for topside and trouble-spot coverage; and (e) low-level (i.e., 20-mW) portable units.

DRS Technologies Canada Ltd.

ICTRS PUMA portable unit (at right), a fixed station, and an adapter for the damage control SCBA mask.

DRS Technologies Canada Ltd. of Kanata, Ontario, which provides SHINCOM (but is not a radio system supplier), was contracted to study potential solutions to the FELEX hands-free wireless mandate. Three options were presented: (1) the USN Hydra trunked LMR; (2) the French Navy's DNCS voice over Internet protocol (VoIP); and (3) the DRS in-house system using Bluetooth for PSDC and WiFi for mobile. Cellular was not considered because the initial study deemed the required infrastructure would be too complex, and there were licensing issues.

Finally, the U.S. Navy's Space and Naval Warfare Systems Command (SPAWAR – since renamed NAVWAR) invited the ICS Project Manager and Engineering Change Project Manager for a two-day Hydra familiarization visit, during which we toured the USS *Leyte Gulf* (CG-55). The friendly support from the USN and SPAWAR was very much appreciated, and the RCN later decided to make full use of the trials and results from the USN Hydra development, and not reinvent the wheel.

The system specification was written based on a trunked LMR system for both PSCD and mobile profiles. Due to the nature of RCN vessels, it was decided that the wireless ICS would include EMSEC isolation elements, especially with regards to opportunistic pickup from red areas. Full military band (380-400 MHz) operability was required for flexibility in NATO task groups. Although SPAWAR offered their services for the design of the DAS, a Canadian implementation was desired. The Naval Engineering Test Establishment (NETE) was duly engaged to design the DAS (incorporating an EMSEC isolation panel), and the fibre interconnect cables between the split stations, and to write up the test documentation. Although conceptually based on the USN Hydra system, the DAS would be designed from the ground up by NETE and the ICTRS project team.

NETE's approach placed great emphasis on redundancy, overlapping coverage areas, and facilitating damage repair. Reducing RF spillage off the ship was another important factor in the design. With a preliminary DAS configuration in mind, NETE conducted coverage testing aboard HMCS *Winnipeg* (FFH-338) with the assistance of Base Information Services, Fleet Maintenance Facility Cape Breton (FMFCB) in Esquimalt, British Columbia, and the EC project manager. Terminated RTL segments held up by "human stand-offs" were utilized as the radiators. NETE then prepared a guidance package for the DAS engineering change. Iterating on the Hydra approach, the ICTRS DAS radiators had a modular design to facilitate cross-patching and emergency repair.

(Continues next page...)

Photo by Michael Anthony, NETE

The (black) cable run for the distributed antenna system through the Gunners Stores flats.

Photo by Michael Anthony, NETE

The ICTRS base station.

Photo by Algis Jurenas

The DAS Rx Extension cable run topside.

Implementation and testing

The DAS and the RF equipment were split into two subprojects. The DAS installation started on the sixth frigate going into midlife refit, while the RF equipment installations followed two ships later. RF equipment was procured via competitive tender, with only IP packet switching excluded — cellular and other systems could bid. Three bids were received: Two for narrow-band FM systems, and the winning bid from TETRA Selex Communications, with DRS as the prime contractor and system integrator.

The RF equipment procurement provided each ship with:

- 47 PUMA portable radios (referred to as a mobile subscriber (MS) terminals);
- two fixed radios;
- two base/repeater stations, each with a two-hour uninterruptable power source (UPS) tying into the DAS; and
- voice-telephony interface (VTI) to SHINCOM, which ties ICTRS talk groups to SHINCOM 'nets,' and also facilitates dialed number point-to-point calls between the two systems.

During integration, the OEM developed two headset adapters — one specifically for damage control (DC), and one standard. The DC adapter interfaces to the Dragar self-contained breathing apparatus (SCBA) helmets. Its levels are set to work with the SCBA interface, and provide both VOX and push-to-talk operation. The standard headset adapters connect to the standard Sennheiser SHINCOM headsets, and to headsets modified to fit with army helmets. The VOX sensitivity and triggering profile was tailored for use with the 50-cal. machine guns.

The installation of the RF equipment lagged the DAS installation by two years. After the DAS was installed on HMC ships *Charlottetown* (FFH-339) and *Vancouver* (FFH-331), NETE used test instruments to perform a physical audit, coverage verification, and a passive relay assessment aboard *Vancouver*. Weak and non-existent coverage areas were identified and flagged for confirmation in the upcoming harbour acceptance trial (HAT). While not a requirement, passive relay was identified as a useful artifact of a passive DAS by SPAWAR. If the base radio equipment is down, the DAS RTL lines extend the communication range between any personal radio communication devices operating in simplex mode. NETE testing aboard *Vancouver* validated this bonus feature.

Once the first complete baseline system was installed in HMCS *St. John's* (FFH-340), a HAT that was performed to document actual coverage throughout the ship confirmed that coverage on the upper-deck was inadequate, and didn't meet the FELEX ICS Statement of Requirements. A fix called the DAS RX Extension, consisting of two exterior runs of RTL feeding into low-noise amplifier assemblies, was installed to boost the uplink signals from portables to the base station. FMFCB tested the fix aboard HMCS *Fredericton* (FFH-337), and found that the RX Extension was successful in correcting the upper-deck coverage deficiencies.

The default configuration of the PUMA mobile subscriber radios was also found to be cumbersome and not user-friendly. Fortunately, Alain Richer de LaFleche (the new LCMM and current ECPM), had naval sailing experience, and was able to simplify and standardize the operational configuration for all ships. Several other areas of the ICTRS required some trouble-shooting, and in the summer and fall of 2021, ICTRS initial cadre training took place at CFB Halifax, with FMF Cape Scott personnel attending and assisting. There seemed to be good appreciation for the merits of the ICTRS, and an eagerness to see the system fully operational.

Algis Jurenas is an engineer with the Major Surface Combatant Project, and a subject matter expert and technical authority for the Halifax-class Internal Communications Trunked Radio System upgrade.

Submissions to the *Journal*

FEATURE ARTICLE

A Proposal to Relocate the Logic Reset Button for the Converter Cabinets aboard the Arctic and Offshore Patrol Vessels*

By MS Matthew Hawes
(Technical Advisor: PO2 Mathieu Allard-Audet)
[*Adapted from a July 2022 Naval Fleet School (Atlantic) Mar Tech RQ-PO2 course student Technical Service Paper.]

The Royal Canadian Navy's new *Harry DeWolf*-class Arctic and offshore patrol vessels (AOPVs) are fitted with two propulsion power-converter cabinets located in the port and starboard upper motor rooms (Figure 1). The eight-compartment cabinets convert the frequency of the electric motor supply, which in turn adjusts the speed of the ship, thus providing power to the respective shaft.

Should an error or fault occur with one of the cabinets, the result could be a loss of power on the affected side. If the programmable logic controller (PLC) cannot be reset using a touch screen interface, a High Voltage Switching Schedule (HVSS) procedure must be followed before a technician can physically open the cabinet to activate the pushbutton reset switch. The checklist procedure can be time-consuming, and still present a potential electrical hazard to the person opening the cabinet.

Technical Background and the Problem

The two GE MV7315 converter cabinets fitted on the AOPVs are medium-voltage, variable-frequency drives comprised of injection enhanced gate transistors. This system uses a three-level, neutral-point voltage source inverter to permit pulse-width modulation, which allows the voltage to be a high-power waveform. The cabinets are cooled using deionized water that circulates through a heat-exchanger.

Figure 1. Converter cabinet in the starboard upper motor room aboard HMCS *Margaret Brooke* (AOPV-431).

When an AOPV experiences an error or fault with a cabinet's PLC, it can shut down, resulting in a loss of power to the respective shaft. An attempt to clear the fault would first be made via the human-machine interface, but if that fails, a member of the ship's staff would have to follow an HVSS checklist procedure to isolate the high voltage to the affected side, open the cabinet, and press the small reset button (Figure 2). Apart from exposing the individual to electric shock, it could take anywhere from 90 minutes to two hours before the ship is able to revert to full-power operation.

In order to minimize the amount of time that an affected shaft is not operating, and to reduce the risk of electrical hazard to personnel, an investigation was made into a work-around that would eliminate the need for an HVSS, reduce the time required to reset the converter cabinet logic, and reduce the potential hazards.

Search for a Solution

Two possible solution options were examined as part of a student-directed technical investigation in support of Naval Fleet School (Atlantic) course requirements. The first involved relocating the PLC pushbutton reset to the exterior door of the current cabinet, while a second option involved relocating the reset button to a less high-voltage area inside the cabinets. Both solutions would ultimately lessen the risk to personnel and operational capability.

In Option A, the reset button would be relocated to the outside of the cabinet door (Figure 3), with an affixed cover to prevent accidental operation. This would make it possible to quickly reset the logic, or clear an alarm fault,

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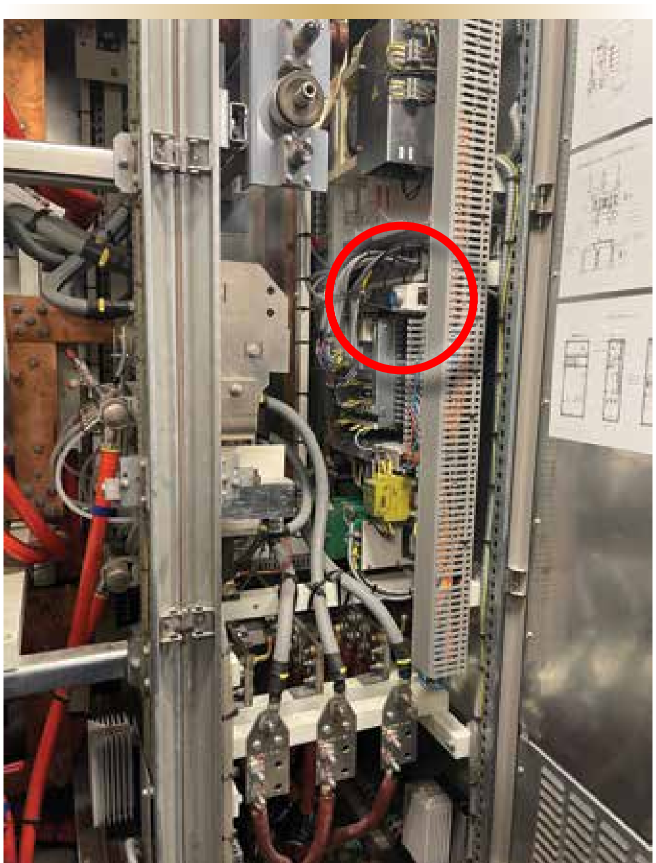


Figure 2. Current location of the logic reset button inside the ILC converter cabinet.

Figure 3. The cabinet with a mocked-up exterior logic reset pushbutton affixed.

thereby preventing the need for an HVSS. The Fleet Maintenance Facility could modify the control cabinet to relocate the reset button to the exterior of the cabinet, and energize it using the existing power supply.

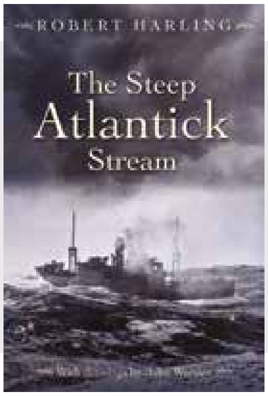
With Option B, the reset button would remain inside the converter cabinet, but would be relocated to the converter local control (CLC), six compartments to the left of its current location. This compartment houses the programmable logic controller (PLC), as well as an uninterruptible power supply, and is not considered to be a high-voltage location. However, there is still the risk of exposure to low-voltage circuits. In addition, personnel requiring key access to this cabinet would need authorization from the ship's Naval Technical Officer, Electrical Manager, or IPMS technician.

While both options meet the established criteria, Option A is clearly the preferred solution. Simply relocating the reset button to the outside of its current compartment makes the most sense, in that it allows an individual to reset the logic without having to open any cabinets, eliminates the need for an HVSS, and reduces the time needed to conduct the reset, lessening the risk to personnel and operational capability.

It is therefore recommended that an Unsatisfactory Condition Report (UCR) be raised concerning the location of the logic reset button, and that Fleet Maintenance Facility Cape Scott and ship's staff conduct a trial on the effectiveness of Option A. Upon successful completion of the trial, an Engineering Change (EC) can be raised to install the proposed option in the AOPVs.

Master Sailor Matthew Hawes is Senior Electrician aboard HMCS Max Bernays (AOPV-432).

Title of Interest



The Steep Atlantick Stream

By Robert Harling

Imprint: Seaforth Publishing

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ISBN 10: 1399072889

232 pages, 8 line drawings

Publication Date: 01 December 2022

Format: Hardback

John Worsley and Seaforth Publishing

The title of this book, first published in 1946, is from a John Milton quote, and perfectly suits this atmospheric memoir of the Battle of the Atlantic. Robert Harling (1910-2008), who served as a Royal Naval Volunteer Reserve (RNVR) lieutenant during the Second World War, offers one of the most original accounts of war at sea aboard a corvette. His text, supported with evocative chapter heading drawings by official war artist John Worsley, describes life aboard HMS *Tobias* as they escorted Atlantic convoys, experienced the terror of U-boat attacks, endured autumn gales, and enjoyed the relief of shore runs in ports on both sides of the ocean.

The narrative begins with Harling's voyage from the Clyde to New York aboard the *Queen Mary*, on route to Halifax to join the newly-built corvette as First Lieutenant. During the early years of the war, corvettes produced in Canada would see service with the Royal Navy, the United States Navy, and other forces under various transfer arrangements. Harling's service aboard *Tobias* began in the spring of 1941, just as the Battle of the Atlantic was entering its most crucial stage. During his first east-bound convoy, he was to experience attacks by U-boats, the loss of merchant vessels, and a steep learning curve as the ship's crew struggled to live in the harsh wartime conditions. Later that summer they made return voyages to Iceland, where runs ashore offered some solace from dangerous days at sea. Time was also spent in the South Atlantic, with voyages to the African ports of Freetown, Sierra Leone, and Lagos, Nigeria, before a short, exciting interlude fighting with the Royal Navy's Coastal Forces. The corvette subsequently returned to escorting convoys from Halifax to Europe.

Robert Harling was a key figure in mid-twentieth century graphic design, and editor of House & Gardens from 1957 to 1993. When he volunteered with the RNVR at the start of the war, he was already a keen amateur sailor, and was placed in charge of a whaler during the evacuation of 338,000 Allied soldiers from Dunkirk in the spring of 1940. His account of this massive rescue operation in Amateur Sailor, a semi-autobiographical book published in 1944 under the pseudonym of Nicholas Drew, was hailed by Poet Laureate John Masefield as the best eyewitness account of Dunkirk ever written.

As Derek Law writes in the new introduction to The Steep Atlantick Stream, reprinted by Seaforth in 2022, Robert Harling's "astonishingly varied and successful" wartime service included a meet-up with Ian Fleming, who recruited him into the world of naval intelligence, and "a dramatic dash across Germany to Magdeburg to round up German scientists."

Harling's absorbing memoir is both serious and humorous, and his picture of wartime Britain, his descriptions of being buffeted by great storm-tossed seas in the 'cockleshell corvettes,' and the recounting of grim losses are all too real and authentic. His words will resonate with sailors everywhere.

The story ends as Harling leaves his ship after a violent cold has developed into pneumonia, and he hears soon afterward the heart-breaking news of the ship's loss, along with the captain and half the crew, after being torpedoed. All that is left for him, it seems, is to ponder on the many "tombless dead consigned by the war to the Steep Atlantick Stream."

NEWS BRIEF

HMCS *Venture* — Defence on the Dock "Battlefleet" Game

By Joshua Hawthorne

Defence on the Dock (DotD), an annual event designed to showcase the Canadian Armed Forces (CAF) and to educate the public on the huge range of career possibilities the CAF has to offer, was held in downtown Victoria on September 17, 2022.

For the event, **Captain Jeffery Klassen**, head of Canadian Forces Base (CFB) Esquimalt Public Affairs, collaborated with the Research and Development (R&D) section of the Design, Development and Evaluation (DDE) division of the naval officer training facility HMCS *Venture*. Together, we created a Canadianized version of the well-known Milton Bradley game, Battleship®.

The Royal Canadian Navy (RCN) Battlefleet game was developed to demonstrate the capabilities, ingenuity and work of the R&D section of the DDE division, which specializes in the use of augmented reality (AR), virtual reality (VR), 3D printing, video production and more in support of HMCS *Venture*'s divisions. Computer models of RCN ships were scaled to match the size of the original Battleship game pieces, and manufactured using a 3D printer so that they could be played on a normal Battleship game board.

New game rules were developed to include exciting twists with mines, the Cyclone helicopter, and the dreaded Kraken, all complemented by a deck of "Unfortunate Event" cards. **Albert Chou**, **MS Josh Mowatt**, **Kajsa Reed** and **MS Alex England** play-tested the game to finalize the rules. Communications specialist Kajsa and Production Team lead and graphic artist **Chantelle Klassen** then designed, produced, translated, printed and laminated a double-sided rule sheet to accompany the game pieces and the board. Chantelle also created the branding and labels for the RCN Battlefleet game sets.

The game was very popular at DotD, and was a lot of fun watching kids sit down to play a round with some of our Navy team members.

Joshua Hawthorne is a Learning Specialist with the RCN Research & Development section of the Design, Development & Evaluation Division at HMCS Venture, Esquimalt.

Photo courtesy HMCS *Venture*.

You sank my frigate! HMCS *Venture*'s new RCN Battlefleet game for the CAF's 2022 Defence on the Dock event was a hit with everyone.

Photo courtesy HMCS *Venture*.

HMCS *Venture*'s Albert Chou and Kajsa Reed play-test Battlefleet to finalize the rules. (Albert won!)

Photo by Brian McCullough

RCN Battlefleet, complete with Canadian Navy vessels and a Cyclone helicopter. (Can you spot the Kraken?)

AWARDS

Weir Canada Award

Lt(N) Julien Godding
Top Marine Systems Engineering Phase VI candidate
(With Mr. Joel Parent)

L-3 Harris-Saunders Memorial Award

Lt(N) Andy Lee
Top student, Marine Systems Engineering Applications Course *(With Cmdre Keith Coffen)*

Mexican Navy Award

SLt Cael Halvorsen
Top student, Naval Combat Systems Engineering Applications Course
(With Cmdre Michel Thibault)

Canadian Fleet Atlantic 2021 Sailor of the Year

S1 Victoria Croney
At the time, a Mar Tech aboard HMCS *Montréal*.
(With Cmdre Chris Robinson, former Commander CANFLTLANT, Feb. 3, 2022.)

Watch for more Award notices in our next edition!

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James Franklin Carruthers, CD, PhD, Captain(N) (RCN Ret'd) (1943-2021)
The Visionary Force behind the RCN's Fully Integrated Combat Data Systems

By Cdr (Ret'd) Ken Bowering

When friends of Jim Carruthers gathered at his Ottawa-area home on July 16, 2022 to say farewell to a shipmate, naval engineer, father, husband and friend who'd lost his lengthy battle against prostate cancer, they were saying goodbye to the man who is widely recognized as the catalyst for ushering in a new era of modern combat data systems for the Royal Canadian Navy (RCN) and, indeed, for Allied navies.

Jim was born on May 14, 1943 in Drumheller AB, and went on to enjoy a remarkable engineering career, first with the RCN (1961-1982), and then with Ottawa's high-technology industry before retiring in 2006. He was a workaholic, whether in his naval, business, or philanthropic persona, and his personal style was to push the envelope whenever and however he could.

Jim enrolled in the Regular Officer Training Plan at the age of 18 and first attended Royal Roads Military College in Victoria, BC. After two years there, he transferred to RMC in Kingston, ON where, in 1965, he completed undergraduate studies in electrical engineering, and was commissioned Sub-Lieutenant, RCN. Little did he realize that the environment he was entering would prove to be such fertile ground for an engineering officer with his intelligence, energy, and determination to get things done.

The Navy and supporting organizations that Jim was immersing himself in during the 1960s featured a "fleet" of outstanding RCN and civilian engineers who were already leaving their mark on the state of naval engineering in Canada. They included such luminaries as: **VAdm Robert Stephens**, who led the 1958 Nuclear Submarine Survey Team; **VAdm John (Jock) Allan**, who served as project manager for the PM DDH-280 Project, Commander of Maritime Command, and Deputy Chief of the Defence Staff; **Professor John Plant**, principal at the Royal Military College; **VAdm Charles (Chuck) Thomas**, who served as Commander Maritime Command, and Vice Chief of the Defence Staff; **RAdm Eldon (Ed) Healey**, who served as project manager for the Canadian Patrol Frigate Project, Chief of Engineering and Maintenance, and ADM Materiel; **Capt(N) Norm Smyth**, who was deputy PM for the CPF Project, and a long-time CEO within Canada's defence industry; and **Capt(N) Marc Garneau**, who became Canada's first astronaut, and later a senior federal cabinet minister.

Photos courtesy the family, except where noted.

Royal Military College Cadet James Carruthers would maintain ties with his alma mater throughout his naval and civilian careers.

As he took his own place among this group, Jim Carruthers would come to stand out as a great visionary. Others saw this capacity in him, and it was when he joined HMCS *Gatineau* (DDE-236) in 1965 that he first met Ed Healey, then a lieutenant-commander and the ship's engineering officer, and the man who would influence and mentor Jim throughout his naval career.

In the latter part of the 1960s, Jim worked alongside **Cdr Max Reid**, and **LCdrs Cam McIntyre** and **Jerry Smuck** as the ASROC system evaluation officer for sea trials of the prototype AN/SQS-505 hull-mounted and variable-depth sonar system aboard HMCS *Terra Nova*

(IRE-259). Those trials completed, in 1971 Jim commenced post-graduate studies in electrical engineering (digital machines) at Nova Scotia Technical College in Halifax, receiving his PhD in 1974. Now a lieutenant-commander, Jim joined the Directorate of Maritime Combat Systems (DMCS) at NDHQ in Ottawa, where he began his seminal work on what would become known as the Shipboard Integrated Processing and Display System, or SHINPADS.

By this time the Navy was operating its new DDH-280-class destroyers, ships that would carry the RCN into the guided missile age. These new "Sisters of the Space Age" featured an integrated combat system in which all combat systems communicated with one another through a central command & control system (CCS-280). It wasn't an elegant form of integration, in that the various combat systems — sonar, radar, electronic warfare, surface & air weapons, tactical data link — came from different suppliers, and each had its own unique interface and data structure. This is where Jim's visionary approach came to the forefront.

In joining DMCS 7, the Action Information section that would later be known as Combat Data Systems, Jim took over a couple of projects that his predecessor **LCdr Howie Burman** had begun. One of those was ADLIPS (Automatic Data Link Plotting System), an R&D project to enable the RCN's older destroyer escorts to operate seamlessly with the new DDH-280s. The second was SAILS, the Shipboard Action Information Link System project that Jim Carruthers would build upon in developing SHINPADS.

As mentioned, the DDH-280s had several very different computer systems, each one of which used a unique programming language and data (word) structure. Jim's thought was that it would be more efficient in terms of data transfer, and less costly in terms of development and support, if there were a single standard in play for the computers, programming language, digital interface, and user display interface. By 1974, others in DMCS 7 had already approached computer industry professionals to assess the benefits of adopting a standard computer and standard programming language, and it was the result of this study that gave impetus to Jim's thesis.

DMCS 7 had also purchased four or five commercial mini-computers, and funded Defence Research Establishment Ottawa to subject them to the traditional "shake, rattle and roll" tests to determine if they could survive and operate in the naval environment. None of them passed, so the RCN decided instead to go with the USN's AN/UYK-20 standard mini-computer. How the Canadian Navy acquired its first units is a story in itself, and had "Jim Carruthers" written all over it (see **Thinking Outside the Box**).

Later, under Jim's direction, the RCN created the AN/UYK-505 — an AN/UYK-20 chassis and processor, but with significantly more memory, all of it solid-state — and later, the AN/UYK-507 modular micro-processor. At the same time, still mid-1970s, Jim was looking at all ship systems, not just combat systems. He envisaged a total ship integration concept where all important functions could be completely controlled, under all combat conditions, via one networked system. To achieve this, the system would require reliable data communications and a standard user interface. Jim recognized these needs, and championed development of a standard multi-function display, a product that would be manufactured by Computing Devices Canada (now General Dynamics Canada).

Jim also capitalized on another DMCS 7 R&D project that investigated the use of fibre-optic technology to provide speed, and data security. From this he envisaged a single data bus, probably using fibre-optic wire (even though that technology was very immature in 1974-75), being run in multiple paths throughout the ship to provide data integrity, security, and battle damage redundancy. His "total ship concept" envisaged a scenario where a ship could be at action stations and, from somewhere deep in the bowels of the ship, all of the ship's combat command & control functions could be performed from a single multi-function display.

This was his SHINPADS concept, but it wasn't always smooth sailing, especially with the "bean counters." Nevertheless, in typical Jim Carruthers style, the more some people objected, the more he persevered with his vision. He knew he was on the right track. During an official presentation of his SHINPADS concept south of the border, it was endorsed with open arms and the pledge: "If the RCN won't fund it, the USN will."

Back home, a meeting of the Defence Management Committee was hastily convened to review the situation. When Ed Healey laid out the SHINPADS concept for the Committee, the response from Deputy Minister **Charles (Buzz) Nixon** (a former naval engineer),

(Continues next page)

AN/SYA-4 display consoles.

Photo by Hughes Aircraft Co.

Thinking Outside the Box

When the cruiser USS *Belknap* (CG-26) and aircraft carrier USS *John F. Kennedy* (CV-67) collided off the coast of Sicily on November 22, 1975, leaving eight sailors dead and causing millions of dollars damage to both ships, *Belknap* lost its entire superstructure, including the combat information center that housed its naval tactical data system. Despite the extensive damage, the USN decided to repair the ship and return it to operational service. However, it first had to procure the destroyed combat equipment. Everything was available except for one essential item — the AN/SYA-4 displays that were no longer in production.

In Ottawa, LCdr Jim Carruthers became aware of the US Navy's search for replacements, and immediately recalled that the RCN had purchased several of these displays in the 1960s, and modified them for use with the RCN's FHE-400 hydrofoil project (HMCS *Bras d'Or*). The project was cancelled in 1971, but Jim managed to locate the displays at Crown Assets where they were awaiting disposal. He was able to recover them, and while DMCS 7 technician Art Gill (ex-C2LT) removed the modifications that had been made years earlier, a trade was negotiated with the USN. The displays would be handed over in exchange for four AN/UYK-20 computers, thus giving the RCN first delivery of its recently selected standard processor.

— Ken Bowering

Jim and his wife Gail.

During the late 1960s and early 1970s, Jim Carruthers participated as a project and evaluation officer for the installation and test firings of the RUR-5 anti-submarine rocket (ASROC) system aboard HMC ships *Terra Nova* (IRE-259) and *Gatineau* (IRE-236).

Jim at the helm on the Ottawa River near his Constance Bay home.

and Chief of the Defence Staff **Gen. Ramsay Withers** (also an engineer), was unequivocal: Why has this not come forward before? The government is looking for projects like this. Get this out to contract ASAP! The bean counters wisely realized that discretion at this point was the better part of valour.

In the 1990s, when the Canadian patrol frigates (CPFs) came to be, and when the DDH-280s got their TRUMP mid-life modernization, SHINPADS was invoked — not so much by the RCN, but by industry. It wasn't the entire concept as Jim had envisaged it, but it was a single data bus, standard displays, and standard computers. It is still the basis for combat systems integration in the modernized *Halifax*-class CPFs, and is a concept which, in principle if not in practice, has also been adopted by Allied navies.

Leaving NDHQ in 1981, Jim was promoted Captain(Navy), and appointed Commanding Officer of Naval Engineering Unit (Atlantic), double-hatted as D/COS Engineering and Maintenance on the Admiral's Staff at Maritime Command Headquarters in Halifax. By this time, all major naval combatants carried a Combat Systems Engineer as part of their crew, and here was another opportunity for Jim to contribute. Having served in a similar capacity aboard HMCS *Terra Nova* more than a decade earlier, Jim took it upon himself to extend his technical management responsibilities by meeting one-on-one with the fleet CSEs, thus nurturing the future of combat systems engineering in the RCN.

Jim served in the RCN for roughly 22 years, retiring in 1982 in the rank of Capt(N). He then worked another 24 years in Ottawa's high-technology industry. Throughout his professional careers, Jim encouraged others to drive hard, be prepared, and never give up on something you are convinced is the right thing to do.

In 2007, having retired from the high-tech industry, Jim returned to his naval roots by joining what is now the Naval Association of Canada. He was the powerhouse behind transforming the NAC into what it is today, and served as President of the Ottawa Chapter from 2012 to 2013, then as National President from 2013 to 2017. In 2017 he was awarded the prestigious RCN Admiral's Medal (now administered by the NAC), in recognition of his many contributions to maritime affairs.

Jim Carruthers' passing on November 1, 2021 left a void in many communities — communities he avidly supported — including the RMC Foundation, the Canadian Naval Technical History Association (CNTHA), and the Naval Association of Canada. His proudest philanthropic deeds included annual scholarships and other awards in support of his alma mater, the Royal Military College of Canada, the institution where as a disadvantaged kid from the prairies his inner talents and sheer grit were allowed to shine.

Ken Bowering served in the Navy from 1960 to 1981, and was the first naval officer to be posted to sea as a Combat Systems Engineer. In the mid-to-late 1970s, he and Jim Carruthers worked in the DMCS 7 Action Information section at NDHQ, and worked together again later as civilians at Norpak Corporation in Kanata, Ontario.

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