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Maritime Engineering Journal

Canada's Naval Technical Forum

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Spring
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Featured Content

CFMETR — The Canadian Forces Maritime Experimental and Test Ranges at 60!

CNTHA
News Inside!

Canada

"I name you *Protecteur*..."

Photo by Lt(N) Kelvin Szeto, PMO
JSS Detachment Vancouver

Photo courtesy Seaspan

Ship's sponsor Teri McKinnon (inset) breaks a bottle of Black Hills Estate Winery Brut across the bow of the Navy's first Joint Support Ship *Protecteur*, on launch day at Seaspan's North Vancouver Shipyard, December 13, 2024.

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Canadian Forces Maritime Experimental and Test Ranges personnel load MK-30 targets onto the Canadian torpedo and sound ranging vessel, CFAV *Stikine* (YTP 613) at CFMETR, Nanoose Bay, BC.

2024 photo by Anna Taylor, Naval Undersea Warfare Center Division Keyport

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COMMODORE'S CORNER

The Pace of Change Continues Unabated for the Defence Team, the Materiel Group and the Navy

By Commodore Keith Coffen, CD

In September 2024, the Materiel Group welcomed **Judith Bennett** as our new Associate Assistant Deputy Minister. Mrs. Bennett is a Professional Engineer and Project Management Professional, with nearly three decades of service in managing Canada's defence assets and interests through the Canadian Armed Forces, the Department of National Defence, and Public Services and Procurement Canada. She has an undergraduate degree in civil engineering from the Royal Military College of Canada, and is a graduate of the University of Ottawa's Telfer School of Management, with a master's degree in Complex Project Leadership. Mrs. Bennett served in the Materiel Group previously as Director General Materiel Systems and Supply Chain, and was most recently Director General Infrastructure and Environment Engineering Services with DND's Infrastructure and Environment Group.

December 2024 marked another major milestone for Canada's National Shipbuilding Strategy, with the launching and naming ceremony for the future HMCS *Protecteur* (AOR-520), the first of two joint support ships under construction at the Seaspan Vancouver Shipyard. Among those in attendance were **Prime Minister, the Right Honourable Justin Trudeau**, as well as the Commander of the Royal Canadian Navy, **Vice-Admiral Angus Topshee**. The ship's sponsor was **Teri McKinnon**, an alumna of the Canadian Navy Leaders at Sea program, and a founder of the Ship to Shore Pilot Project that connects elementary school students virtually with units of the RCN.

Here in MEPM, changes are afoot as well. We have embarked on an organizational review to ensure that the Division is able to provide the most effective, efficient, and economical support for the RCN's new and future fleets. With the delivery of the future HMCS *Robert Hampton Gray* (AOPV-435) scheduled for later this year, the *Harry DeWolf*-class will be fully in service, and over the next few short years the Navy will take delivery of both joint support ships as well. Five years from now it is expected that the RCN will be operating four major vessel classes, with the *Halifax*-class frigates, *Harry* DeWolf-class Arctic and offshore patrol vessels, *Protecteur*-class replenishment ships, and *Victoria*-class submarines. The delivery of the first River-class destroyer, HMCS *Fraser*, won't be far behind, and if things go well — noting that we still have some ground to cover on both files before they become fully-fledged projects — replacement submarines and a new, optionally crewed surface vessel will also join the fleet.

Photo courtesy DND

Judith Bennett, Associate Assistant Deputy Minister (Materiel)

The River Class, in particular, will drive a number of changes to the Division's tasks. The larger size and complexity of the ship, as well as newer technologies including the Aegis Combat System, will stretch our capabilities and organization. To respond to these challenges, we are launching MEPM30, a series of reviews aimed at examining options for the future organizational structure of the Division. An early first step will be to consolidate MEPM's common-to-fleet services under Director Naval Platform Systems, which will take place in April. Further changes will be made as MEPM30 advances.

As we look forward to the future, we must also honour our past. Two noteworthy examples of this are the "second retirements" that took place in MEPM earlier this year for **CPO1 (Ret'd) Jeannie Teague**, and **LCdr (Ret'd) Jack Logan**. Jeannie retired from the Administrative Services Group with a combined military and public service career spanning nearly 60 years, while Jack was an Engineering Group public servant with a combined military and public service career covering nearly 50 years. Both Jeannie and Jack have been cornerstones of the MEPM community and culture for as long as I have been in service, and I wish them both fair winds and following seas.

No less noteworthy is a handover between editors of the *Maritime Engineering Journal*, the longest-running CAF branch journal in its class still in continuous publication. After 43 years and 111 issues, **LCdr (Ret'd) Brian McCullough** is handing off production editing responsibilities to **LCdr (Ret'd) Ann Mech**, as he steps back into an advisory role. Words simply cannot do justice to the impact that Brian, a former Naval Reserve navigation officer, has had on the Naval Technical community. Having been the heart and soul of the *Journal* for such a long time, he's been providing a forum to over 3,000 uniformed, and more than 10,000 civilian members of the government and industry Naval Technical communities, where lessons learned can be exchanged and where perspectives can be freely shared for the benefit of all. On behalf of the entire Naval Technical community, I would very much like to thank Brian for his more than 53 years of combined service, and to welcome Ann aboard.

I also wish to acknowledge the recent passing of a Naval Technical branch sailor, **Petty Officer 2nd Class Gregory Applin**, a Weapons Engineering Technician, who died in a tragic small-boat accident in Halifax Harbour on January 24. A fellow Newfoundlander, Greg was well-known by many in the Division who had sailed with him, and he will be sorely missed. His loss is a jarring reminder of the risks that RCN sailors face at all times, and I extend my heartfelt condolences to Greg's family, friends, and shipmates aboard HMCS *Montréal*.

As always, I am proud of the work that is done by this Division, and by the wider Naval Technical community, to learn and adapt as we support the RCN and look toward the future. Individuals and organizations may change, but our mandate of service to Canadians, to the Defence Team, to the RCN, and to our sailors themselves, endures, along with a professional culture rooted in respect, continuous learning, collaboration, and excellence.

I wish you all a safe and happy spring season, and hope that you find this issue of the *Journal* informative and thought-provoking.

FORUM

Letter to the Editor

Re: Ernest Apps and the Radar of Matapan (MEJ 110)

As noted in your Looking Back article, author and journalist Stanley Burke was a WWII RCNVR officer, but better known at the time was his older brother, LCdr Cornelius Burke. Both brothers commanded motor gunboats (MGBs) during the war, and "Corny" Burke's courageous exploits in the Adriatic and Mediterranean earned him a Distinguished Service Cross and two bars, as well as a Mention in Dispatches.

Also, five months before the events described in the article relating to S/Lt Apps, another young "Special Branch" Canadian radar officer by the name of S/Lt George H. Kirkpatrick (Pat) Strathy was killed in action in near Sicily on October 12, 1940 while serving aboard the light cruiser HMS *Ajax*. The brilliant 22-year-old mathematics graduate of Trinity College (U of T) was buried at sea, but his name lives on. Admiral Sir Andrew Cunningham, C-in-C Mediterranean Fleet, mentioned him in his autobiography, "A Sailor's Odyssey," and Strathy Road in Ajax, Ontario is named in his honour.

— **Cdr Pat DC Barnhouse, OMM, CD, RCN(Ret'd)**

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 at MEJ.Submissions@gmail.com.

IN MEMORIAM

Charles McKinnon Cameron
(1934 – 2024)

The Royal Canadian Navy lost one of its most stalwart civilian naval engineers and outstanding characters, last December 22, with the passing of Charles McKinnon Cameron in Victoria at the age of 90. For those who didn't know him, or perhaps never even heard of his impact on the Navy, it would not be an exaggeration to describe him as one of the key facilitators in the acceptance of the *Halifax*-class frigates. In short, the delivery of the RCN's main surface fleet in service today depended on this "peripatetic Scotsman's" unique talent for ensuring that contractors involved with the Canadian Patrol Frigate (CPF) made good on their deliverables — no ifs, ands or buts.

To say that this man was an institution would be a distinct understatement. During his 45 years of support to the materiel branch of the RCN, Charlie Cameron was a virtually unstoppable force of personality, conviction, and energy, whose breadth and depth of knowledge were matched only by his determination to see a job done properly. Many of us who worked with or around him stood in awe of his intense personality, and wondered whether he might have been born with a wheel-spanner in one hand, and a cellphone in the other!

Charlie was born into a farming family in Johnstone, Renfrewshire, Scotland west of Glasgow. During the war, his family would barter with neighbouring farms to get a complete inventory of groceries despite the rations imposed on the nation. Early on, Charlie expressed a desire to go to sea, but when his poor eyesight precluded a deck officer's career, he joined Clydeside's Fairfield Shipbuilding and Engineering Company to develop his credentials as a marine engineer. He signed on as a pipefitter, which led to an apprenticeship as a piping design draughtsman, and it was with this skill that he immigrated to Canada in June 1957. After 18 months in Victoria, he joined the Naval Central Drawing Office at Canadian Vickers in Montreal, and then in 1978 joined the Department of National Defence in Ottawa. From then until his retirement from the Public Service in November 2003, his career was solely concerned with improving the material state of the ships of the RCN. One might also suggest that he took a corresponding interest in the professional state of the RCN's naval engineers.

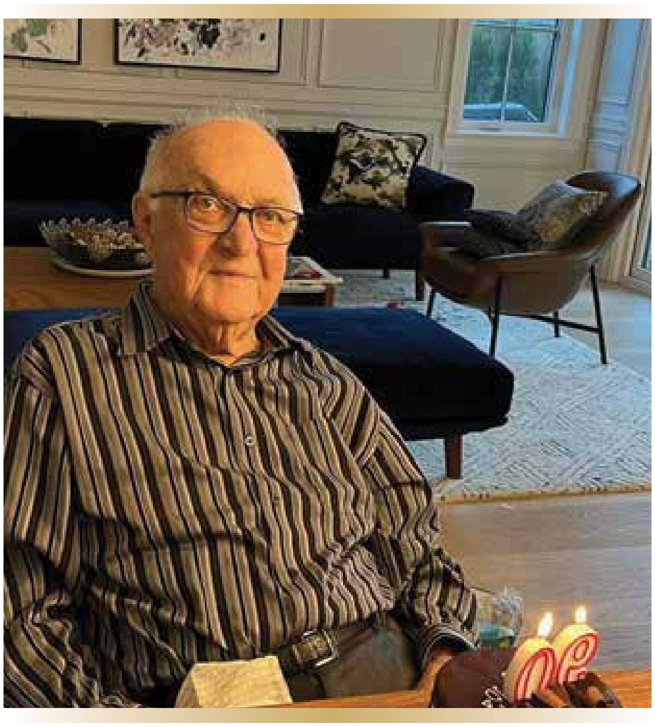


Photo courtesy Cameron family archives

Charles Cameron: Independent to the end.

Charlie's retirement event in November 2003 featured accolades from a wide spectrum of senior naval officers, colleagues and friends, not all of whom were engineers. Their reminiscences attested to his force of character, and to his unparalleled powers of persuasion — "A bulldozer with a brogue!" one person described him. Straightforward and unvarnished, you always knew where you stood with Charlie. There were numerous mentions of what it was like to be on the receiving end of one of his robust and cheerfully opinionated "mentoring sessions," which was something akin to experiencing a personality-infused version of the case-hardening of gears. But there was no shame in being "Cameronized" by Charlie, because you came away from the exchange with ever more respect for the man. His manner may have been brusque, but everyone knew he was simply taking the shortest route to getting the work done to spec as professionally and expeditiously as possible.

This combination of knowledge, and an ability to "impart it" in a meaningful way, led to Charlie being deputized by the Director of Marine and Electrical Engineering to assist the CPF lead yard in witnessing the frigate trials, and holding Saint John Shipbuilding Limited (SJSL) and their subcontractors to account with respect to their contracted deliverables. There were many mentions of his immeasurable contributions to the CPF project, with tales of Charlie's personally selected technical experts — known by one and all as Charlie's Angels — "descending on the peaceful tranquility of the shipyard like an avenging host" as they tracked down nonconformance errors made in transforming the contract specifications into a ship afloat. Selected for their expertise, and ability to make correct decisions on the spot, their goal was always focused on achieving the best possible outcome for the Navy.

Two wonderful vignettes from the CPF trials program, when Charlie was at the apex of his career, serve to illustrate how he cemented his reputation for conviction, drive, and a commitment to personal and professional excellence.

The first relates to a heeling trial that was conducted to prove that all ship systems could continue to operate when the ship was inclined at an angle of 20 degrees. This was a lengthy, complex trial that involved loading a series of huge concrete clumps on one side of the flight deck to heel the ship by stages. Suffice it to say, this pre-empted any other work being carried out on the ship. As the trial progressed, Charlie and the SJSL trials director got into an increasingly heated debate over when "enough heel was enough" to sign off on the trial, with Charlie stubbornly insisting that the ship be inclined to the full 20 degrees. The result was that, at about 12 degrees of heel, two of the four diesel generators self-destructed due to a design flaw in the lube-oil system. A fix was duly engineered by the manufacturer, dubbed "the Canadian mod," and was back-fitted to many other diesels in service. This was one of many instances where Charlie's credibility and force of personality with the shipyard swayed the argument to the lasting benefit of the Navy.

The second occurred during first-of-class builder's trials, when Charlie faced intense pressure to take short-cuts to maintain the scheduled four-day program. He was having none of it, and kept the teams to their task for 11 days before he was satisfied. Not surprisingly, he had many people wondering whether either the trials team or the ship would survive. At one point, the Royal Schelde representative turned to Charlie and asked mildly if it was Canadian Navy policy to destroy the first ship. But, as Charlie would have said, the proof was in the pudding.

Charlie was not a slave to process, and there were numerous references to "CharlieMods." While ordinary mortals had to go through copious paperwork to implement a design change, it seemed all Charlie Cameron needed was a quick sketch on a table napkin to get things rolling. When one commodore encountered Charlie thus engaged in an airport waiting lounge, and asked what he was up to, Charlie smiled and replied, "Ah, sir, you don't really want to know, but it's coming along nicely." While it was often left to others to clear up the paperwork fallout, every "CharlieMod" was necessary, and made a valuable improvement to the class. Apparently, relaxations from configuration management rigour applied only to Charles Cameron. All others were to follow the proscribed Engineering Change process.

While Charlie mostly kept his family life private, he was a dedicated husband, father and grandfather. His beloved wife of 56 years, **Jenny**, predeceased him in 2011, but he is succeeded by two wonderful daughters, **Joanna and Carrie**, and six grandchildren. He was immensely proud of his family, whose independence and success in life confirm both sides of the nature/nurture debate. Charlie lived his life fiercely independently to the last minute, with a full social calendar and an active driver's license. He was a unique character, and will be sorely missed by those of us who knew him as a friend.

**— Submitted by Rear-Admiral (Ret'd)
Richard Greenwood**


RCN photo

FEATURE ARTICLE

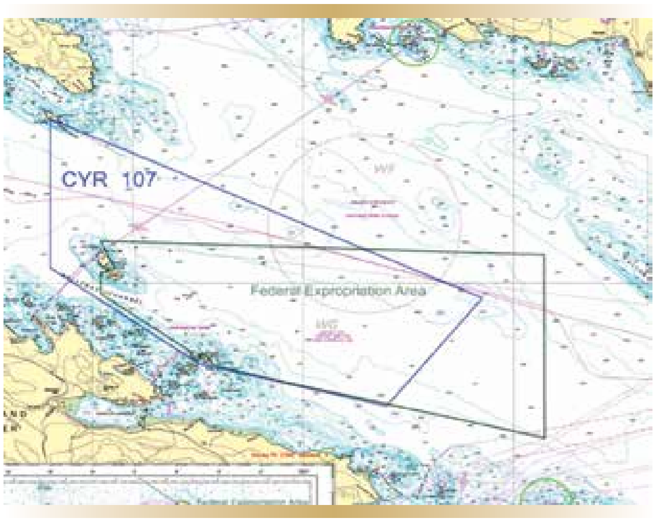
Canadian Forces Maritime Experimental and Test Ranges (CFMETR) – 60th Anniversary!

By Stephen McCormick, CD, P.L.Eng.

HMCS *Chicoutimi* photo by Terry Berkeley, CFMETR

Not a lot of people know what exactly happens at CFMETR, or perhaps even where it's located, but one thing is certain. For well over half a century, this jointly funded Canadian-American three-dimensional range facility at Nanoose, BC has been supporting the Canadian and United States militaries through operational testing of non-explosive torpedoes, sonobuoys, ship and helicopter sonars, and facilitating anti-submarine warfare training for ship and air crews. The range is closed to civilian traffic during operations.

Situated across the Strait of Georgia from Vancouver, CFMETR's primary deep-water test site (Area WG) and associated airspace (CYR-107) in the Salish Sea are in use 12 months of the year. Thanks to annual open house events for the public, and respectful relations with local First Nations community leaders, the 70 permanent range personnel, along with visiting American staff and crews, enjoy a great quality of life as they live and work along one



DND photo

Situated across the Strait of Georgia from Vancouver, CFMETR's primary deep-water test site (Area WG) and associated airspace (CYR-107) in the Salish Sea.

CFMETR photo

2024 photo by Anna Taylor, Naval Undersea Warfare Center Division Keyport

CFMETR supports a wide range of anti-submarine air operations.

of the West Coast's most beautiful stretches of coastline. Popular local folklore about sightings of a "Yellow Submarine" and a "mysterious cave" in nearby Notch Hill just add to the enjoyment.

While the current formal construct of the joint facility dates back to May 1965, the Royal Canadian Navy began operating a site at Patricia Bay north of Victoria as early as the Second World War for testing and preparing torpedoes destined for service aboard ships, submarines and aircraft operating in the Pacific Ocean. In August 1941, the Royal Air Force's No. 32 Operational Training Unit transferred from England to Pat Bay in search of "less crowded skies" on Canada's West Coast, and was soon training British, Canadian, Australian, and New Zealand aircrews in the fine art of torpedo bombing using battle-tested Bristol Beaufort aircraft.[1]

In those days, determining the success or failure of a torpedo test run required direct observation by technicians standing on platforms positioned along the centreline of the range. Armed only with stopwatches, they would observe what they could as the torpedo sped down the range. A net lowered vertically into the water would be used to confirm what depth the torpedo was running at as it passed through the mesh. When serious torpedo problems became evident during actual wartime use, it was clear that the limited testing was not fully adequate to understanding the performance of these weapons, or uncovering potential problems. This quickly resulted in the application of new technologies to the process of weapon testing, which contributed to the eventual development of more reliable torpedoes.

Beginnings at Nanoose Bay

The history of naval torpedo testing at Nanoose Bay began in December 1953, when **Commodore W.G. Ross**, RCN Director General for Naval Ordnance confirmed that the deep, quiet waters of Area WG would be suitable for ranging the more advanced torpedoes that ran faster and deeper than previous variants. The Navy wasted no time, and in January 1954, shortly after the move to the new site from Pat Bay, two new Mk-32 torpedoes were being ranged at Nanoose. The United States Navy also had new torpedoes that carried sonar systems with longer acquisition ranges, but these would have been acoustically limited by the confines of the US test ranges. Before the Strait of Georgia site at Nanoose Bay was selected, other potential tracking range sites in Alaska and Canada were considered, but none offered the combined advantages of a large volume of water, good weather conditions for nearly year-around operations, and reasonably close proximity to the US Naval Undersea Warfare Center (NUWC) torpedo analysis facility at Keyport, Washington, known as Torpedo Town USA.

2024 photo by Anna Taylor, Naval Undersea Warfare Center Division Keyport

NUWC Division, Keyport Commanding Officer, Capt. Clint Hoskins (left) and Cdr Craig Piccolo, CFMETR Commanding Officer at the Canadian Forces Maritime Experimental and Test Ranges facility headquarters building, Feb. 13, 2024.

(Continues next page...)

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[1] https://legionmagazine.com/flying-right-torpedoes-air-force-part-43/

Following several years of discussions, negotiations and planning, Canada and the United States signed a formal agreement on May 18, 1965, establishing Nanoose as a jointly operated underwater weapons range that would eventually become known as the Canadian Forces Maritime Experimental and Test Ranges (CFMETR), an Assistant Deputy Minister (Materiel) Field Unit. Her Majesty Queen Elizabeth II approved the unit crest in 1978.

Range Capabilities

In the early 1960s, both navies had begun shifting emphasis away from torpedo attacks solely against surface ships, to include torpedo attacks against deep-diving enemy submarines. A new generation of highly manoeuvrable torpedoes able to seek out submerged targets at great depths would spawn a new generation of tracking technologies. A major advantage offered by the Nanoose range site was that while it was deep enough for testing down to several hundred metres, it was not so deep that a torpedo that sank at the end of its run could not be recovered intact from the muddy, obstruction-free bottom. The range's 3-D tracking capability, coupled with long-life acoustic locating pingers in the torpedoes themselves, ensured that any torpedo sinking to the bottom of the range could be easily located.


CFMETR photo

A Kineto tracking mount at Rocky Point, Nanaimo.

The acoustic-based tracking system at Nanoose was installed on the heels of the partnering agreement with the USN. In 1969, two cine-sextant optical tracking systems were installed to obtain in-air trajectory data for correlation with the 3-D acoustic data. Each cine-sextant system included two separate cameras, a 35-mm camera to the left of the operator and a 70-mm camera to the operator's right. The data from the two cine-sextant sites consists of two elevation angles and two azimuth angles to provide a 3-D location of the airborne object by triangulation. With its integrated optical and acoustic tracking capability, the Nanoose range site was now able to integrate the in-air portion of the trajectory with both the surface and underwater tracks to produce a complete picture of the exercise. This provided an important capability that was truly unique to this tracking range site. In 2011, the cine-sextants were modernized with Kineto torque-motor-driven tracking mounts that deliver smooth, jitter-free tracking to ensure precise time, space and position information.

In 1970, the Nanoose tracking range was doubled in size to provide about 32 square nautical miles of acoustic tracking, which provided enough area to fully evaluate the new Mk-48 torpedo. Then in 1992, the range was further expanded to 44 square nautical miles, employing 29 bottom-mounted arrays. A shallow-water array was added near Winchelsea Island in 1995 to support torpedo research and development in shallow, rough-bottom conditions.

The main range's 29 short baseline, bottom-mounted arrays, with 10-metre hydrophone spacing in x, y, z and c planes, are used to compile a 3-D picture of a test run. The geometry of the short baseline array components allows

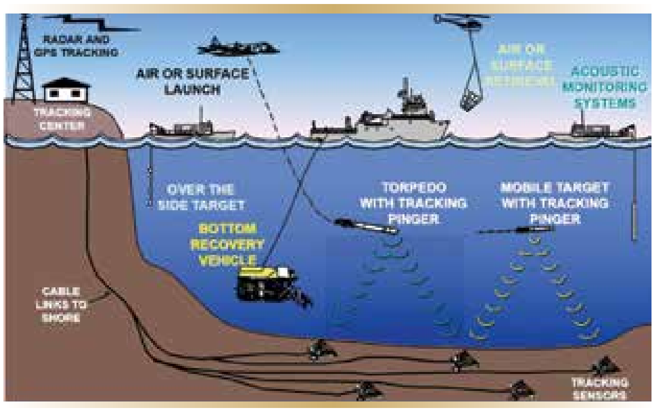

Image courtesy NUWC Keyport, WA

Geometry schematic of a typical 3-D underwater tracking range.


CFMETR photo

CFMETR Range Operations Facility on Winchelsea Island.

time measurements to be made of an acoustic tracking pulse as it sweeps through the array, then computes a direction vector, tracing it back to the origin of the pinger signal on the weapon or vehicle. The length of the vector defines the distance between the vehicle and each of the four hydrophones of a specific array component. By the use of simple formulas, the time and vector values can be very precisely converted into a "sound ray path" to provide a complete 3-D position of the vehicle at every moment of its run. For this method of tracking to be accurate, the array location, tilt, and rotation with respect to the range coordinate system must have been precisely determined by an array survey, and the sound velocity profile of the surrounding water must be accurately measured.

One of the reasons for arranging the hydrophones at the corners of a cube, as was done on the first short baseline arrays, was to ensure that tracking could be accomplished using rather simple mathematical operations. Other array geometries would have required the computation of square roots. This operation may be taken for granted these days, but in the early 1960s, calculating square roots in real time was not an easy task for analogue computers.

Upgrades

As the number of new platforms and spectrum of applications increased, it became clear that CFMETR and NUWC needed to review the current level of range technology. Several internal studies were conducted from 2015-2020 to define existing range limitations in light of current and expected future Navy range requirements. The result was that the analogue arrays and associated technology from the 1960s and 1970s were found to be in need of a technical refresh. New platforms and equipment, such as the CH-148 Cyclone helicopter and associated HELRAS dipping sonar, AN/SQS-565 LF sonobuoys, joint support ships, Arctic and offshore patrol vessels, and the Underwater Warfare Suite Upgrade for the *Halifax*-class frigates were also driving the Canadian requirement to have a modernized test range. The River-class destroyer, Mk-54 lightweight torpedo, and new Canadian patrol submarines that will soon follow will also require the latest in range tehnologies in order to realize the full potential of their systems.

The US has a similar host of new programs and technologies that require these upgrades, and financial commitments have been provided to upgrade the Pacific Northwest ranges to an all-digital, all-fibre tracking system. In keeping with our International Agreement, Canada will contribute some infrastructure upgrades to the overall

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CFMETR Environmental Program

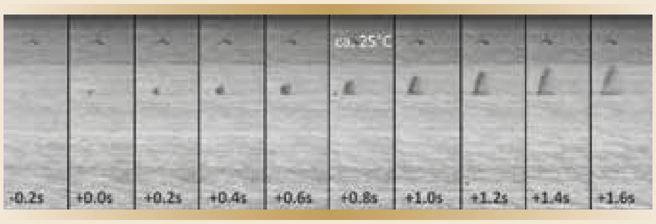

Photo by Daniel Zitterbart, Woods Hole Oceanographic Institution, used with permission.

Thermal imaging detects the apparent temperature difference between the surface of the sea and an object above the surface – in this case a whale's spout.

Range operations at CFMETR are planned to mitigate potential negative impacts on the marine environment. Where marine mammals and seabirds are concerned, the Marine Mammal Monitoring and Recognition (M3R) system discussed in detail in *MEJ* 90 (Summer 2019) has been installed, and is now working. Future improvements to the previously mentioned all-fibre US range modernization project will realize the full potential of M3R. Further improvements include the installation of a machine learning cryo-cooled infrared camera system that will be able to distinguish whale blows when the animals are surfacing, adding to our ability to detect, localize and classify marine mammals. CFMETR is also monitoring cetaceans (whales, dolphins, and porpoises), Steller sea lions, California sea lions, and marbled murrelets (small seabird), among others.

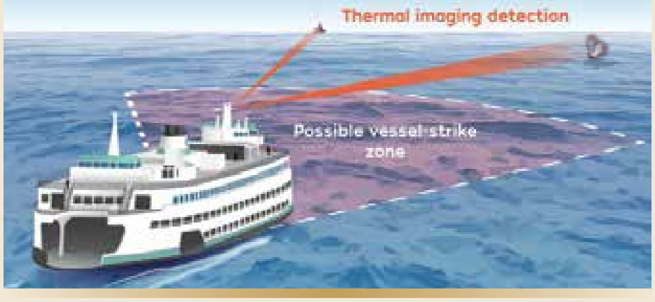

Photo by Stephen McCormick, CFMETR

Torpedo and sounding ranging vessels CFAV Stikine (613) and CFAV Sikanni (611) have been supporting operations at CFMETR for decades.

project. Once completed, the new and improved range facilities will have the ability to process and distribute data faster and more efficiently, meet all current cyber security rules, and enable live, virtual and constructive (LVC) simulation events.

Conclusion

For more than 60 years, CFMETR has provided a valuable contribution to Canada's defence program. The 3-D tracking system at Nanoose not only serves as a good example of a successful joint international facility, it is also one of the finest underwater ranges of its type in the free world. Continued partnership with our US allies, investment in range systems, and delivery of modern warships and aircraft to the RCN will ensure that CFMETR provides state-of-the-art range services well into the foreseeable future.

◆

Stephen McCormick is the current CFMETR Range Engineer. After a 23-year career as a Naval Combat Systems Engineering Officer, he joined Lockheed Martin as the Project Engineer for HCM FELEX ships Vancouver and Regina before joining CFMETR in 2017.

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Photo by Cdr Craig Piccolo, CO CFMETR

In February, CFMETR took delivery of the first of three new range security vessels. From left to right: Ben Porter and Rex Bishop (DGMEPM(NC)), CFMETR Range Engineer Stephen McCormick, Mikaela Renaud (PSPC), and John McKillop (Zodiac Milpro).

FEATURE ARTICLE

Clarifying the “Hype” over Hypersonic Missiles

By LCdr Byron A. Ross

Generated using Microsoft CoPilot, prompt: “*A photorealistic image depicting a hypersonic glide vehicle travelling through the upper atmosphere at high altitude, descending towards a coastal area,*” 07 Nov 2024.

The decades-old concept of “hypersonics” has become somewhat popular, of late, in discussions regarding the characterization a missile’s speed. While terms such as “subsonic” and “supersonic” remain in the lexicon as easily understood meanings relating to the speed of sound through a medium, the implementation of “hypersonic” as a characterization has proven less effective due to misconceptions surrounding its use.

During the Cold War, ballistic missiles were perceived as the ultimate weapon system, capable of delivering massively destructive effects at extended ranges in a relatively short time, and with few vulnerabilities once launched. These would be complemented by slower, stealthier, long-range cruise missiles, supplanting crewed bomber aircraft, but which required the forward positioning of vulnerable launch platforms. The recent re-emergence of the hypersonic concept was initially associated with renewed efforts to seek military advantage as a conceptual response to evolving, increasingly capable, ballistic-missile defence capabilities. These include the resolution of several outstanding impediments to implementation relating to aerodynamics, propulsion, and guidance & control, which will eventually lead to the unveiling of missile systems advertising hypersonic capabilities. The intent of this article is to offer a clearer understanding of the concept, such that hypersonic claims may be assessed in a more critical and objective manner.

As the term hypersonic is intended as a means of characterizing speed, it is important to understand the underlying elements that are associated with it. First, the invocation of “sonic” implies something relative to the speed of sound, which by definition is not a static value. Rather, it is proportional to the density of the medium through which the sound is travelling. In the case of the atmosphere, the density of the air is not always linearly correlated as it can be influenced by a variety of factors, including temperature and pressure. In general, as altitude increases, air density decreases, eventually reaching a point where the localized pressure approaches that of a vacuum. At this point sound can no longer propagate because there are insufficient atoms present within the medium to support the mechanical transfer of acoustic energy – hence, the popular saying, “In space, no one can hear you scream.”[1]

Characterizing speed by comparing it to the speed of sound is typically constrained to when an object is in flight within the atmosphere, and is done by employing the Mach

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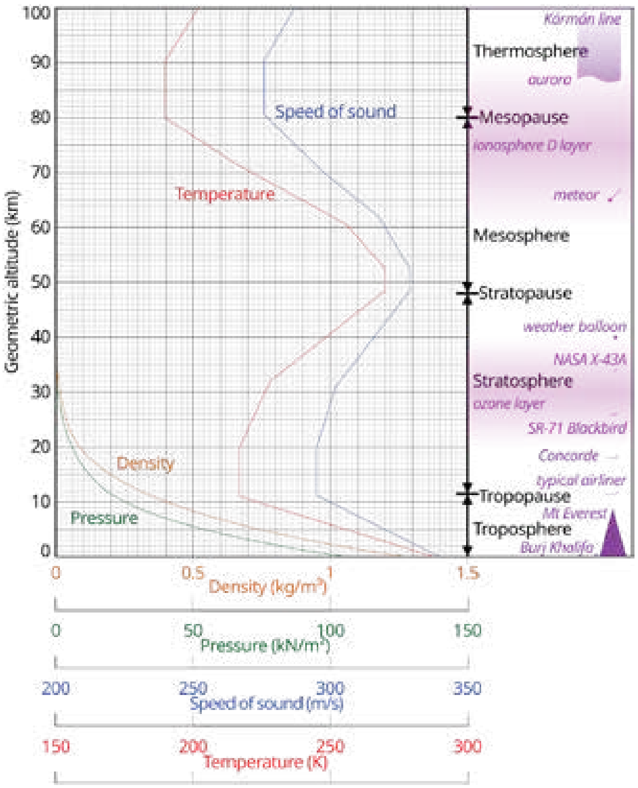
[1] Made popular as the tagline to the 1979 film “Alien.”

number construct. This is a scalar correlation of the speed of an object relative to that of sound in the same medium, represented by the letter M.[2] The second part of the term, “hyper,” can be colloquially described as “greater than super.” NASA characterizes hypersonic speeds as M>5, where the speed of the object is five or more times greater than the local speed of sound, and further describes “high hypersonic” as speeds in excess of M 25.[3] It is worth noting that this frame of reference is typically only employed in air, as the speed of sound in other mediums, principally land and water, is significantly higher relative to the bodies that travel on or through them.[4]

Misconceptions

The first misconception surrounds the contextual framing of the stated speed of a missile. Not all missiles maintain a consistent speed throughout the entirety of their operation, and, subject to the propulsion construct, the way their speed changes over time may also vary. For example, consider a glide vehicle accelerated to altitude and velocity by one or more rocket boosters. In this case, the maximum speed typically occurs while still under power as it approaches its maximum altitude, where the air is less dense, and therefore so too is the aerodynamic drag. Once the final rocket booster stage is expended, there is no further propulsive force being applied to accelerate the glide vehicle further, and thus it begins to decelerate as it approaches apogee. It accelerates again if or when it passes apogee, albeit this time, courtesy of gravity, presuming a parabolic-esque trajectory. So, while the peak speed of such a vehicle may be M 10 or greater, the speed of such a vehicle over the remainder of its flight may be less than M 5, resulting in an overall average speed that would not satisfy the criteria to be classified as hypersonic. By contrast, a cruise missile capable of *sustained* hypersonic speeds may have a lower peak speed, but also less of a difference between its peak and cruise speeds, and therefore have a higher average speed that would satisfy the aforementioned criteria.



Density and pressure effects fall off relatively quickly (and smoothly), whereas temperature varies in a more complex fashion with altitude, with a more significant influence on the speed of sound.

By Cmglee – Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=17311330

The second misconception is a little more elusive, focusing on the extent to which a missile is capable of manoeuvring by leveraging aerodynamic lift. This is an important, often omitted element, serving to delineate hypersonic systems from traditional ballistic missiles which often achieve hypersonic speeds, especially those with intermediate and intercontinental ranges. This line remains blurry as the latter incorporates increasingly agile payloads capable of similar aerodynamic manoeuvring following their re-entry into the atmosphere. While specific definitions and characterization of aerodynamic agility vary, this author endorses the delineation that in order to be characterized as a hypersonic missile, it must be capable of significantly deviating from a parabolic trajectory common to conventional ballistic systems. In other words, the system must be capable of making more than a terminal phase aimpoint adjustment.

Admittedly, this element is subjective and remains ambiguous. The follow-on caveat is further so, in that the requirement to deviate from a parabolic ballistic trajectory can be for a variety of reasons, including axial, by reducing

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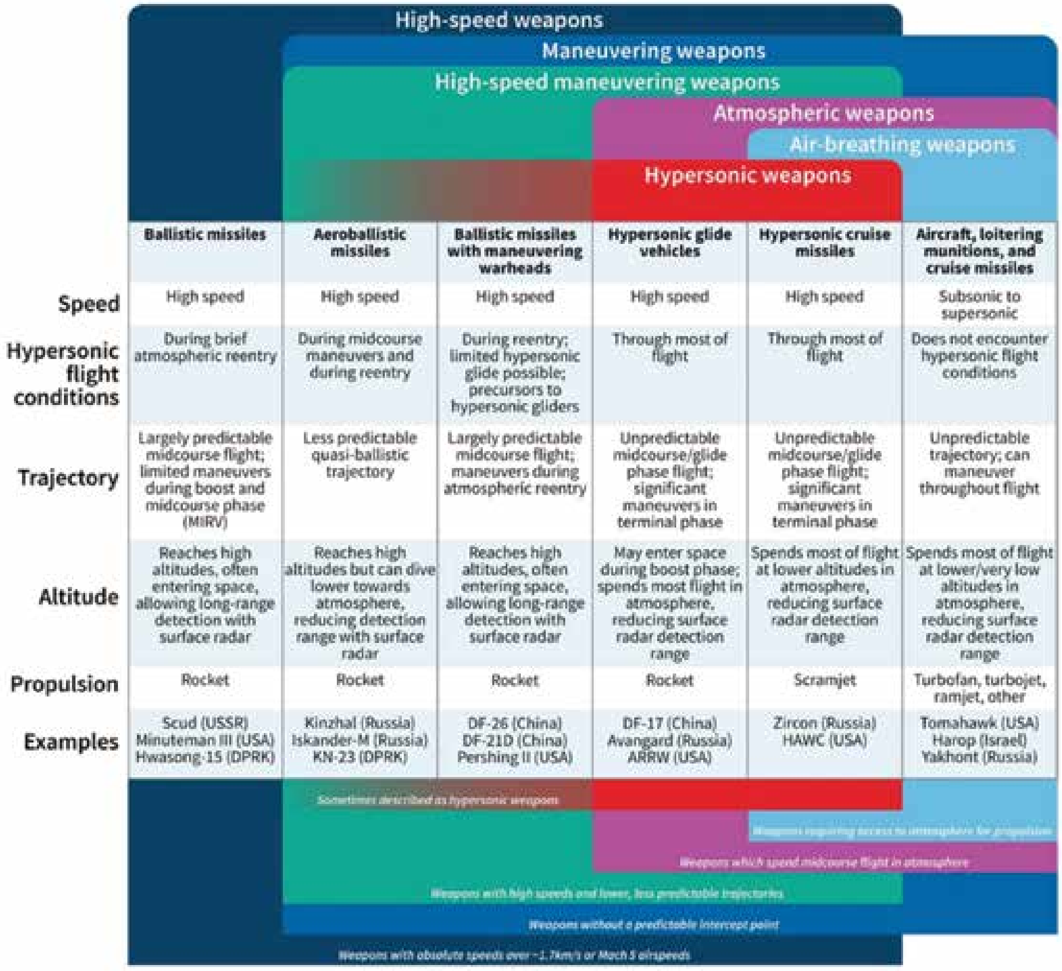
2. In military circles, the speed of sound may not always be properly contextualized by specifying whether the speed of sound employed is at sea level or altitude, and whether or not it is derived from International Standard Atmosphere charts.
3. “Speed of Sound,” Glenn Research Center, National Aeronautics and Space Administration, https://www.grc.nasa.gov/www/k-12/BGP/sound.html, accessed 07 Nov 2024.
4. The generalized speed of sound through water is approximated as ~1,500 metres per second (m/s), almost 4.5 times faster than through air, at ~340 m/s. The speed of sound through solids is even higher: eg., ~6,000 m/s in granite, and ~12,000m/s in diamond.



	Ballistic missiles	Aeroballistic missiles	Ballistic missiles with maneuvering warheads	Hypersonic glide vehicles	Hypersonic cruise missiles	Aircraft, loitering munitions, and cruise missiles
Speed	High speed	High speed	High speed	High speed	High speed	Subsonic to supersonic
Hypersonic flight conditions	During brief atmospheric reentry	During midcourse maneuvers and during reentry	During reentry; limited hypersonic glide possible; precursors to hypersonic gliders	Through most of flight	Through most of flight	Does not encounter hypersonic flight conditions
Trajectory	Largely predictable midcourse flight; limited maneuvers during boost and midcourse phase (MIRV)	Less predictable quasi-ballistic trajectory	Largely predictable midcourse flight; maneuvers during atmospheric reentry	Unpredictable midcourse/glide phase flight; significant maneuvers in terminal phase	Unpredictable midcourse/glide phase flight; significant maneuvers in terminal phase	Unpredictable trajectory; can maneuver throughout flight
Altitude	Reaches high altitudes, often entering space, allowing long-range detection with surface radar	Reaches high altitudes but can dive lower towards atmosphere, reducing detection range with surface radar	Reaches high altitudes, often entering space, allowing long-range detection with surface radar	May enter space during boost phase; spends most flight in atmosphere, reducing surface radar detection range	Spends most of flight at lower altitudes in atmosphere, reducing surface radar detection range	Spends most of flight at lower/very low altitudes in atmosphere, reducing surface radar detection range
Propulsion	Rocket	Rocket	Rocket	Rocket	Scramjet	Turbofan, turbojet, ramjet, other
Examples	Scud (USSR) Minuteman III (USA) Hwasong-15 (DPRK)	Kinzhal (Russia) Iskander-M (Russia) KN-23 (DPRK)	DF-26 (China) DF-21D (China) Pershing II (USA)	DF-17 (China) Avangard (Russia) ARRW (USA)	Zircon (Russia) HAWC (USA)	Tomahawk (USA) Harop (Israel) Yakhont (Russia)

Comparison and Characterization of Various Aerial Threats

Source: Complex Air Defence: Countering the Hypersonic Threat, 220207_Karako_Complex_AirDefense.pdf
csis-website-prod.s3.amazonaws.com

or extending range, as well as lateral. Lateral is a divergence from the original flight path in a horizontal manner, often referred to as a "cross-range" adjustment or manoeuvre, which *must be accomplished using aerodynamic means* such as body-generated lift and aerodynamic control surfaces. The imposition of this last argument serves to delineate from ballistic missiles that may rely on boost-phase and/or exo-atmospheric trajectory adjustments, and whose terminal stage(s) proceed to re-enter the atmosphere often at hypersonic and greater speeds without further significant adjustment to their trajectories.[5] In short, a hypersonic system is not constrained to the "ballpark" aligned with the missile's initial ballistic trajectory.

So, while describing a weapon system as hypersonic is technically correct if it satisfies the speed threshold alone, it can be construed as misleading given the emerging and refining definition of a hypersonic vehicle or system. Technically, a long-range artillery rocket may qualify as a hypersonic weapon by virtue of its peak speed alone, but it would not qualify under the second criteria as it typically lacks the ability to significantly deviate from the parabolic trajectory established during the boost phase. The combination of these two characteristics underpins the concern surrounding the threat posed by such systems, due to the way they affect the probability of successfully defending

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5. Modern ballistic missiles typically rely on three types of warhead constructs: Unguided Re-entry Vehicles (RV), which continue to follow the parabolic trajectory established during the boost phase(s) without further correction/adjustment; Multiple Independent Re-entry Vehicles (MIRV), where a penultimate stage frequently referred to as a "bus" or "post-boost vehicle (PBV)" conducts exo-atmospheric manoeuvres using reaction control systems to adjust the trajectory of individual RVs, which then continue on ballistically without further adjustment; and more recently, Manoeuvring Re-Entry Vehicles (MaRV), where the terminal stage has limited reactive and/or aerodynamic authority to make small adjustments to the trajectory once it has re-entered the atmosphere.

against them. Currently, there are two conventional means of defending against such a system; either kinetically, by physically hitting it with an interceptor, or employment of a proximity blast/fragmentation warhead; or non-kinetically, which is defined as achieving defeat through the anything other than kinetic coupling.[6]

Hypersonic Threat Defence

In any engagement, time is a dominant factor for the defender, as any defensive actions require a non-zero amount duration to be implemented. In the defensive construct, hypersonic threats induce challenges throughout all aspects of engagement. First, their overall speed compresses the engagement timelines by reducing the amount of time to react to the threat by virtue of reducing the amount of time required to travel the distance from launch to target. While traditional ballistic missiles may have higher speeds, these speeds are highly deterministic, can be predicted in advance of launch, and are readily extrapolated post-launch. The relatively stable parabolic trajectories employed by most of these systems sees them spending a significant amount of time "above the horizon" in view of the defender, increasing the time during which they can be observed and engaged. Hypersonic weapons exploit the optimization of conventional ballistic missile defence systems that capitalize upon this by enabling atypical trajectories that deviate from this established and expected norm. Their ability to adopt a much lower and more dynamic flight profile potentially increases the time until they are detected and tracked by the defender. Alternatively, if detected during the launch phase, they have the ability to "duck out" of observation by dropping below the observation horizon and re-entering it later on, possibly from a different azimuth that is less defended.

Defending against a hypersonic weapon is currently perceived to be significantly more costly in both the global sense, with an increased requirement for observation of potential launches and enhanced sensor coverage around defended assets, as well as in a discrete sense with respect to the type and number of sensors and defensive effectors employed. In a practical sense, defeating a hypersonic weapon is a confluence of ballistic and aerodynamic missile defence. Typically, missile systems are countered most effectively before they actually launch. If launched, then the preference would be to engage them while they are still in the highly stressed boost-phase where they are not responsive to threats, merely focused on optimizing the conversion of booster fuel into velocity for their payload, while under extreme structural loading. Next best would be to engage the missile while it is still mid-course, prior to payload separation, but what happens most frequently (for a wide variety of reasons) is that the threat weapon is engaged during its terminal phase.

Any kinematic interceptor intended to be employed against a hypersonic threat needs to possess a combination of range, speed and precision. Thus, it should be able to:

- intercept the target in a sufficiently timely fashion, ideally providing an opportunity to assess and re-engage if required;
- overmatch the agility of the threat, typically, by a ratio of at least 2 to 1 (higher is preferred); and
- deliver the effects to the target.

Given these design considerations, such interceptors are likely to be on the larger side to ensure they possess sufficient propellant to accelerate the requisite combination of sensors, effectors and terminal manoeuvring aids (if fitted) out to the desired range to neutralize the target. All of these design considerations must be effective out to relevant ranges, with sufficient kinematic reserve to close with a potentially manoeuvring target in the relatively limited time available from initial detection, to engaging and neutralizing it.

It is these aforementioned complexities that warrant prudence in using and accepting the term "hypersonic." The ambiguities inherent in the description of such weapon claims have profound implications both in understanding their supposed capabilities, and when considering any defence against them. While predominantly affecting missiles currently, it is anticipated that other military systems sharing these performance characteristics that are *not* missiles will emerge and be subject to the same characterization challenge.

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[6] While there is discussion on-going regarding this terminology (seeking to increase delineation in the non-kinetic realm to incorporate those effects achieved through directed-energy and cyber means), this article will align with that in effect at the time of writing, as laid out above.

FEATURE ARTICLE

The Evolution of Canada's Post-Second World War Navy – Managing a Fleet in Transition

By Ken Bowering

In 1970, National Defence Headquarters (NDHQ) in Ottawa underwent a massive reorganization that affected the three environmental services and their supporting infrastructures. For the Navy, on the operational side, it established a Chief of Maritime Doctrine and Operations organization headed by a rear admiral, and on the support side for all services instituted two branches under a Chief of Supply, and a Chief of Engineering and Maintenance (CEM), the latter overseeing the Land, Air, and Maritime engineering divisions run by military directors general.

One of the most profound impacts brought about by the reorganization was that, for the first time, naval engineering and maintenance would be under one authority – Director General Maritime Engineering and Maintenance, led initially by **Cmdre Bill Christie** (*see MEJ 90*). It also marked the genesis of an RCN engineering life-cycle design and support philosophy that wasn't even on the horizon in the 1950s. DGMEM would itself be reoriented in 1995 as DG Maritime Equipment Program Management, but the philosophy of life-cycle materiel management (LCMM) continued, maturing to the point where it is now an essential part of naval procurement.

It's difficult today to imagine conducting an aggressive shipbuilding program, supported by periodic upgrades and mid-life refits, without a well-defined LCMM system in place, but that's exactly what the RCN did up until 1970.

From the mid-1950s through to the mid-1960s, a series of 20 Canadian-designed and -built ASW destroyer escorts were brought into service in part to fulfill Canada's commitment to NATO during the Cold War. The initial seven DDEs of the *St. Laurent* (205 class) were soon followed by variants made up of seven *Restigouche* (257 class) DDEs, four *Mackenzie* (261 class) DDEs, and, finally, two *Annapolis* (265 class) ships that were purpose-built as helicopter-carrying DDHs. Widely referred to as "Cadillacs" because of their sleek, modern design and upgraded crew amenities such as bunks in lieu of hammocks, the last of these stalwart steam-driven ships would remain operational until the mid-1990s.

Within 10 years of their entering service, the original seven DDEs would be converted to become Improved *St. Laurent*-class (ISL) DDHs, thus showing the tremendous displacement margin that had been built into the original design. Just imagine a ship, 366 feet in length with a displacement of 2,260 tons, having a helicopter deck and hangar added to accommodate a helicopter weighing 11,870 pounds, and then conducting launch and recovery operations in up to sea state 5, thanks to the Canadian invention of the "beartrap" helicopter haul-down and rapid securing device system (*see MEJ 8*). It was a significant engineering accomplishment carried out by a combination of naval air staff at HMCS Shearwater, NS, naval engineering staff in Ottawa, HMC Dockyard Halifax, and Canadian industry. This was just the first of what would eventually be several major improvements for these ships over the years.

The seven follow-on DDEs of the *Restigouche* class were almost copies of the "original seven" *St. Laurent*-class ships. Their main machinery was the same, but there were some changes to the main surface/air gun armament, and to some design aspects of the superstructure. Around the same time, in the early 1960s, the Navy was also building four *Mackenzie*-class DDEs, basically the same as the *Restigouche* class. Then, in the mid-1960s, the final two ships of the *St. Laurent* design, the *Annapolis* class, were built to the same baseline configuration as the ISLs – that is, as DDHs.


RCN photo

HMCS *St. Laurent* (DDE-205)

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While plans were being made to build a follow-on to the *Annapolis* class, the Navy was already looking at improving the fighting capability of the *Restigouche*-class escorts. HMCS *Terra Nova*, the sixth ship of the class, became the Navy's Maritime Operational Test and Evaluation Force (MOTEF) platform for testing the planned system upgrades and/or engineering modifications before final production got underway. This work was conducted on the ship by HMC Dockyard Halifax between May 1965 and February 1966, followed by a lengthy period of sea trials.[1] In the end, budget cuts allowed for only four of the ships to be modernized and reclassed as Improved *Restigouche* (IRE) destroyer escorts: *Terra Nova* (IRE-259), *Gatineau* (IRE-236), *Restigouche* (IRE-257), and *Kootenay* (IRE-258), with the remaining three ships of the *Restigouche* class placed in reserve. Almost all of the IRE modernization refit work was undertaken by the Naval Dockyard in Esquimalt.

Operational improvements for the IREs included better HF and UHF radio communications, a new parametric amplifier for the AN/SPS-12 radar, and the addition of:

- AN/ULQ-6C electronic countermeasure system (ECM)
- SHIELD decoy system;
- 10.3 cm illumination rocket system;
- AN/SQS-505 hull-mounted and variable-depth sonar (VDS) systems, with AN/SQA-502 VDS hoist;
- RUR-5 ASROC anti-submarine rocket system;
- MK-32 triple-barrel torpedo tubes;
- Standard Tensioned Replenishment Alongside Method (STREAM) kingpost for replenishment at sea (RAS);
- improved boiler air-intake system;
- conversion to distillate fuel; and
- improved dining and recreational arrangements (habitability).

By the late 1960s, the follow-on to the *Annapolis* class had morphed into the DDH-280 Tribal-class destroyers, which came on line in the early 1970s. Dubbed the "sisters of the space age," these ships brought the RCN into the age of modern naval warfare with electronic data exchange and guided missiles.

The decades of the 1950s, 1960s and 1970s were clearly a very busy time for the Navy, building, refitting, modernizing, improving, and converting surface combatants. By the end of the 1960s, naval ships that had served during the Second World War and Korean War had all been paid off. In addition to the ongoing naval engineering activities with the main surface fleet of destroyers escorts, the Navy also built the world's fastest warship – the hydrofoil HMCS *Bras d'Or* (FHE-400), built three AOR replenishment ships, acquired two ex-USN submarines and three *Oberon*-class submarines, converted the former Italian fishing trawler *Aspa Quarto* into a fleet diving-support ship – HMCS *Cormorant* (ASL-20), all while operating two oceanographic research ships (CFAVs *Quest* and *Endeavour*), several minesweepers, two Cape-class escort maintenance ships, plus numerous auxiliary vessels and an aircraft carrier. And, even as the calendar was turning over to the 1980s, plans were already in the works for giving the three *Oberon*-class submarines a significant operational refresh in what would become the Submarine Operational Update Project (SOUP).


RCN photo

HMCS *Fraser* conducting helicopter operations

These activities were in addition to managing scheduled refits and short work periods, and occurred while the Navy was also developing many of its own systems and concepts such as the trio of "shipboard integrated" systems for processing and display (SHINPADS), communications (SHINCOM), and machinery control (SHINMACS). There were also developments with an automatic data link and information processing system (ADLIPS), an infrared search and track system (IRST), IR suppression, towed-array sonar, and a Canadian electronic warfare system (CANEWS), among other projects. These successes were a testament to the excellent efforts of Canada's Navy personnel, public servants, and defence industry.

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[1] In 1973, *Terra Nova* transferred to Esquimalt, where the production IRE systems were installed.

Despite all of these accomplishments, there still wasn't a well-thought-out life-cycle management philosophy in play. Going back to the seven original *St. Laurent*-class DDEs, however, one program that was serving the Navy very well was its planned maintenance. This system of periodic machinery/equipment checks and inspections by ships' staff, dockyard personnel during short work periods and refits, and by industry played a key "preventive maintenance" role in extending the service lives of the steamers.

In the mid-1970s, the Ship Replacement Project (SRP) was proposed to replace the Navy's aging fleet. In this three-phase undertaking, SRP I and II were to deliver 12 surface combatants, six ships in each phase, whereas SRP III was undefined as either surface combatants or submarines. SRP I eventually transitioned into the Canadian Patrol Frigate (CPF) Project and, in time, absorbed SRP II as part of it. However, there were delays getting government approval, even for SRP I. Meanwhile, all 20 destroyer escorts based on the *St. Laurent* design, some of which had been improved, converted, modernized, or were still in original condition, were getting more and more expensive to maintain. The longer that the SRP project was delayed, the more was being spent on maintaining these aging ships.

Photo by William Edward Henry

"Cadillac Row" in the Halifax naval dockyard, 1966. HMCS *Terra Nova*'s after 3"50 gun has been removed, and the stern modified to accommodate the variable-depth sonar. The new trellis mast has not yet been fitted. (Notes courtesy Cdr (Ret'd) Barry Sparkes).

DGMEM subsequently undertook a study (the Destroyer Life Cycle Cost Analysis – *see MEJ 110/CNTHA News*) that asked life-cycle materiel managers to estimate what it would cost to keep DDE/DDH/IRE systems operational significantly beyond their original 25-year service lives. The study turned up some very interesting information that the new LCMMs might otherwise never have found. The costs were considerable. So, with the CPF project still not moving as quickly as the Navy wanted, the RCN had little choice but to push forward a Destroyer Life Extension Project (DELEX) based on the findings of the DELCA study. This turned out to be a blessing, as it changed the way life-cycle materiel management was performed, and enabled the Navy to commit ships – including the 31-year-old IRE, HMCS *Terra Nova* – to the Gulf War and other theatres of operation. By the end of the 1990s, the steamer fleet had been totally phased out, replaced by the 12 CPFs.

Conclusion

In the two decades that followed the amazing period of service upkeep and modernization of the steamer fleet during the 1960s and 1970s, the Navy would go on to modernize the DDH-280s under the Tribal Class Update and Modernization Project (TRUMP – *see p. 23*), take delivery of new Canadian patrol frigates and new maritime coastal defence vessels, and bring into service the *Victoria*-class submarines. The CPFs and submarines would later undergo their own modernization and life-extension refits, well-assisted by a solid life-cycle materiel management infrastructure.

Today, as the Navy takes delivery of the last of six new Arctic and offshore patrol ships, builds two new *Protecteur*-class joint support ships, and looks forward to introducing a fleet of new River-class DDGs, it is comforting to know that the in-service support of these ships is assured. For those of us from an earlier generation who managed a Canadian naval fleet in transition, there is some satisfaction in seeing not only how the efforts of the past have influenced the methods of the modern age, but that those who are managing today's challenges are as capable and determined as ever.

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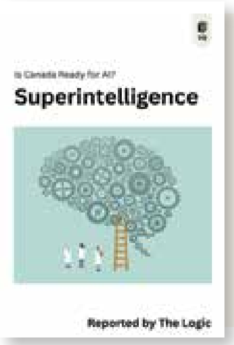
Cdr (Ret'd) Ken Bowering served in the Navy from 1960 to 1981, and was the first naval officer to be posted to sea as a Combat Systems Engineer. He is an active member of the Canadian Naval Technical History Association.

Title of Interest



Superintelligence: Is Canada Ready for AI?

Reported by *The Logic*

Published (2024) by Sutherland House (Toronto)
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95 pages; Appendix; $19.95

Reviewed by Brian McCullough

The Logic advertises itself as "Canada's business and technology newsroom, covering everything from crypto to cleantech." Founded in 2018, the independent quarterly features original reporting and analysis on the organizations, policies, and people driving Canada's innovation economy. The rise of Big Tech and the emergence of disruptive technologies are well within their wheelhouse for discussion.

Each special focus edition brings together in-depth commentaries from an invited lineup of journalists who draw on their own specialty areas of interest to present a comprehensive overview of the subject at hand. In *Superintelligence: Is Canada Ready for AI?*, a dozen such writers use a variety of lenses and economic markers to create a revealing, high-level picture of the state of artificial intelligence in Canada. It is a compelling read.

What the editorial team has produced through this compendium of articles is both a good news story of what Canadians are capable of contributing to the rapidly evolving world of AI technology, and a cautionary tale of how careless or disinterested management at all levels can leave us scratching our heads as we struggle to play catch-up.

As editor-in-chief **David Skok** writes in his introduction, Canada was once on the leading edge of AI research: "We have funded the research, developed the neural networks, and although we are a relatively small country, we have created a first-mover advantage that other, larger nations should envy."

The thought he ponders most, however, is "whether we'll reap the rewards of that early contribution, or wind up a bystander in the increasingly frenzied world of AI."

The book comprises 12 chapters – essay-style examinations of everything from the foundations of AI in Canada, to the implications for this country should tensions over Taiwan interrupt the supply chains that feed much of the world's growing artificial-intelligence industry. Among other concerns, the authors dive into tough problems regarding issues such as:

- access to adequate supercomputing infrastructure so that Canadian startups and researchers can backstop homegrown AI science and products;
- the encouraging yet complex situation surrounding AI-assisted drug therapy research in Canada; and
- the severe consequences relating to fierce competition by the US for Canadian AI talent.

The chapter "On Defence" suggests how the CAF and DND might best position themselves to take advantage of artificial intelligence, notably in the areas of logistics support, surveillance, reconnaissance, and intelligence. According to defence industry professionals who were interviewed, the greatest benefits from AI are likely to be found by building better bridges to private sector innovation, and that Canada's contribution to NATO could focus on pursuing brilliance in specific AI technologies with the aim of becoming the go-to supplier for our allies. Although this chapter was written before the release of *Our North, Strong and Free* in 2024, which addresses AI, it still presents a strong context for Canada's need to ramp up and maintain momentum in embracing AI as a critical element of our defence policy.

Will Canada succeed in reclaiming its place as a "first-mover" on the global AI stage, Skok asks, "or will we follow a path that's all too familiar in this country, squandering our advantages in the face of global competition?"

How this story turns out, the book suggests, is a question of what kind of country Canada wants to be. Our future with AI is clearly in our hands.

(See also, Artificial Intelligence, MEJ 12, January 1987)

NTO Awards

Congratulations to our NTO Award winners who were honoured at the National Capital Region NTO Mess Dinner on Feb. 27, 2025!

Weir Canada Award

Lt(N) Noah Kenney
Top Marine Systems Engineering Officer
(Basic Qualification Board)

Presented by Joël Parent
Executive Director, Weir Canada, Inc.
Naval Engineering Test Establishment (NETE) Montréal

Lockheed Martin Canada Award

Lt(N) William Campbell
Top Naval Combat Systems Engineering Officer
(Basic Qualification Board)

Presented by Simon Hughes
Senior Business Development Manager
Lockheed Martin Canada Inc., Ottawa

Photos by Brian McCullough

Photo courtesy Cdr Adrian Mascarenhas

News Briefs

Launch and Naming Ceremony of HMCS *Protecteur*

(Courtesy Our Navy Today)

Photo courtesy Seaspan

On December 13, a launch and naming ceremony was hosted by Seaspan Shipyards in Vancouver, B.C., for the new Joint Support Ship (JSS), HMCS *Protecteur*. With a length of 173.7 metres, HMCS *Protecteur* is the longest naval vessel ever built in Canada.

In true naval tradition, the ship's sponsor, **Teri McKinnon**, broke a wine bottle across the ship's bow and declared "I name you *Protecteur*. Bless this ship and all who sail in it." *Protecteur* and HMCS *Preserver* will be replacing the former *Protecteur*-class Auxiliary Oiler Replenishment vessels, providing critical at-sea replenishment.

These multi-purpose warships will be capable of seamlessly integrating with any Canadian or allied naval task group. They will significantly extend the range and endurance of these groups through the provision of fuel, ammunition, aviation support, food, spare parts, exercise and gym facilities, and medical and dental care.

> "Today is an exciting day for the Royal Canadian Navy as we move another step closer to delivering the future fleet our sailors need to protect Canada in all three of our oceans and support Canadian interests around the world. The *Protecteur*-class Auxiliary Oiler Replenishment vessel brings with it a history of naval service achieved by the previous *Protecteur-class*, spanning more than 45 years, and ranging from the First Gulf War to humanitarian operations and multinational exercises in all oceans."
>
> ***Vice-Admiral Angus Topshee, Commander Royal Canadian Navy***

News Briefs

Another Chapter Complete in Preparing for Our Future River-class Destroyers!

(Courtesy RCN LinkedIn)

Inside the United States Navy's Combat Systems Engineering Development Site (CSEDS) in Moorestown, NJ is where you can find the RCN's new Aegis Combat System (ACS) Integration Centre. Its unveiling took place on November 21, 2024, with **Rear Admiral Daniel Charlebois**, Director General of Future Ship Capability, having the privilege of opening the facility where the ACS software for the River Class Destroyer (RCD) Project will be developed and tested.

The activation of this facility at CSEDS is an important milestone toward the ultimate goal of delivering the River-class destroyers to Canada. The Aegis Combat System is responsible for the ship's integrated air and missile defence capability that can provide blanket air defence for an entire task group. Once the software has been developed, it will be delivered to the RCD Land Based Testing Facility in Halifax.

River Class Destroyer Project Manager Commodore Michel Thibault (centre) and senior staff were on hand for the unveiling.

Photo courtesy Canada.ca

News Briefs

Making Work Easier with XRF Technology at FMF Cape Breton

By Rory Theriault, Strategic Communications Officer for FMFCB/FMFCS

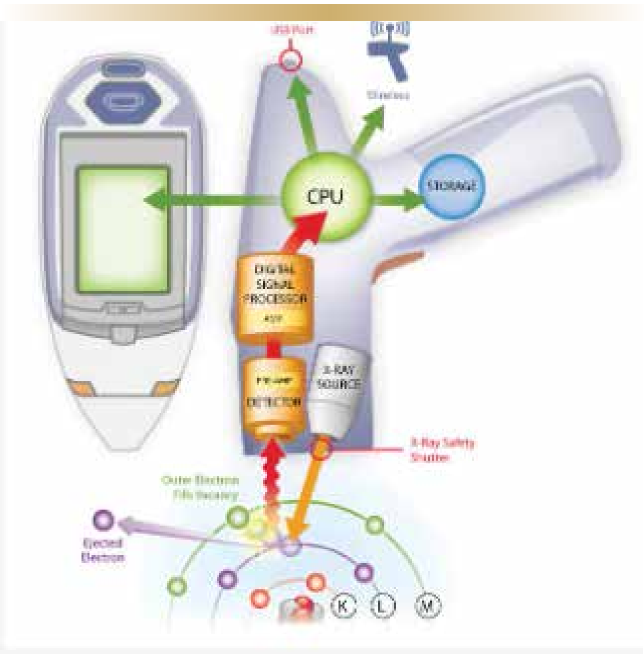
A new X-ray fluorescence (XRF) tool is changing the way FMF Cape Breton staff analyze materials. The handheld device makes it quick and easy to identify what materials are made of, without the need to send samples off-site for testing. Instead of waiting days for results, technicians can now get accurate readings on the spot, as simple as "point and shoot."

The XRF provides a non-destructive analysis by using X-rays to analyze a material. When the X-rays hit the material, they cause it to emit secondary X-rays that the device measures to determine which elements are present. This means technicians can instantly determine things like metal composition, or confirm material grades. It's a game-changer for jobs where knowing the type of material is critical before moving forward.

XRF analyzers can measure a wide array of elements, including but not limited to:

- common metals like iron, copper, and aluminum;
- precious metals such as gold, silver, and platinum;
- environmental pollutants like lead, arsenic, and mercury; and
- rare earth elements like neodymium and europium.

Before XRF, testing meant collecting samples, shipping them off to a lab, and waiting for the results to come back. This caused delays that could slow down projects. Now, with the XRF, that wait time is gone. The tool provides accurate results in seconds, helping jobs get done faster and with fewer interruptions.



Safety is a big part of using this tool. Because it relies on X-ray technology, there are important precautions to follow. FMF is currently working to get more employees trained and licensed to operate the XRF. The training focuses on understanding how the tool works, how to use it properly, and how to ensure everyone stays safe while it's in use.

By using the XRF, FMF Cape Breton is keeping more work in-house, cutting down on costs, and saving time. It's a straightforward way to make material testing easier and more efficient. As more employees get trained on this technology, the benefits will continue to grow, helping FMF to deliver high-quality work faster and more effectively.

The XRF is just one more way FMF is investing in better tools and technology to make jobs smoother and more efficient for everyone. With the right training and tools in hand, the team can focus on getting the work done safely and on time.

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A Short Primer on the Tribal Class Update and Modernization Project (TRUMP)

By Tony Thatcher

Adapted from an original article:
https://www.cntha.ca/articles/trump.html

The DDH-280 Tribal Class Update and Modernization Project (TRUMP) refits conducted during the early 1990s were considered to be the most ambitious Canadian warship conversion program in more than two decades. It was a brilliant undertaking, even though the project took 23 years from conception in 1977 to final completion in 2000, and came in considerably costlier than the government's preliminary 1983 'design-to-cost' estimate of $650 million. This was due in part to the Navy's pressing need for an area air-defence capability, and when the last bills came in, the final cost to upgrade the four destroyers was estimated at $1.4 billion (in 2005 dollars).

Originally there was concern in some quarters that TRUMP might have to be scaled back, possibly by converting fewer than four ships, or by adopting a less expensive update package (i.e. the older Standard 1 missile and Mk-13 launcher) for all four ships. Some cost-saving measures were to update the ships' existing torpedo handling equipment rather than install an entirely new system, and to retain the existing ASW fire-control system. It was decided to discontinue the competitive bidding process and "sole source" the implementation contract to Litton Systems Canada Limited of Toronto, partly on the basis of the urgent needs of the shipbuilding industry.

HMCS *Algonquin* pre-TRUMP

RCN photo

Following the major refits under TRUMP, the DDH-280s emerged as newly pegged *Iroquois*-class area air-defence destroyers. Among other changes, an integrated machinery control system and new gas-turbine engines were installed, and the twin "bunny ear" funnels were replaced with a single large funnel with an IR suppression system. New search and fire-control radars were added, the old 5-inch gun was replaced with a new super-rapid 76-mm, and a Mk-41 vertical launch missile system was installed. Although hampered slightly by the lack of a 3-D radar (cut as a cost-saving measure), they were nonetheless very effective area air-defence destroyers with their Standard SM-2 (MR) missiles.

Implementation

The contract was awarded to Litton in July/August 1985. As prime contractor, Litton acted as Project Manager, and accepted total system responsibility to engineer, procure, construct and deliver the four converted vessels. Litton's team consisted of the following main subcontractors:

- MSEI: Drawings
- MIL-Davie: Shipyard
- Signaal (HSA): Radars, fire-control
- Martin Marietta: Vertical launch system
- Vitro Engineering: Weapons directions system
- General Dynamics: Phalanx CIWS
- OTO Melara: 76-mm super-rapid gun

Issues of Interest

Direct Sale vs. Foreign Military Sales: The original TRUMP project manager, **Capt(N) Robbie Preston**, was able to set up the agreement with the United States Navy (USN) for direct sale, industry to industry, through his experience with Canadian Defence Liaison Staff (Washington). This was unlike the Canadian Patrol Frigate (CPF) Project, which bought its equipment through Foreign Military Sales (FMS), the usual defence procurement export method. The USN agreed to a direct sale arrangement as long as Canada met certain conditions: first that it deal with Vitro Engineering Corporation for the weapons direction system; second, an FMS case was required to provide a mechanism to transfer

(Continues next page...)

documentation and for navy-to-navy liaison; and last, the USN required a Canadian naval liaison officer in Washington to work for the captain of anti-air warfare (AAW) at Naval Sea Systems Command (NAVSEA).

Command and Control System (CCS) Architecture: Litton did not want to run into the troubles the CPF project was having developing a truly distributed SHINPADS-based CCS. Litton designed a federated system, but still had difficulties getting the software to fit in the limited memory of the standard computers required by the Navy. The ability to handle more targets than fire-control channels, and to prioritize weapons handling, was accomplished by uniquely Canadian developed Threat Evaluation Weapon Assignment (TEWA) software.

Standard Missile Block 2 (SM2): This missile came in two versions, Tartar and Aegis, depending on the particular USN vessel and fire-control system. Since the Tartar version was expected to be taken out of service during the lifetime of the TRUMPed vessels, the USN recommended a unique Canadian version be assembled by the USN's Indian Head armament depot at Maryland, DC to account for the *Iroquois*-class fire-control equipment. However, Canada resisted this option, and wanted to be able to operate the Aegis version as it would be common with the USN for the entire lifetime of the ships. The problem was that nobody was sure the Aegis version of the missile could be controlled in the Tartar mode, i.e. discontinuous fire control after launch. The USN permitted Canada access to key naval and industry missile scientific and support personnel to resolve this issue.

Mk-41 Vertical Launch System (VLS): The missile vertical launch system had to be rotated 90 degrees from its orientation in USN ships to fit in the DDH-280 hull because of size constraints, so a change was made to the software in the VLS controller to accommodate this. However, the USN was critical of fitting the system in the 280s because of hull flexure, and felt that it would not work properly as a result. Overall, the USN's VLS project manager was very concerned that the Canadian Navy could not operate the entire Standard Missile system safely. He therefore put a certification program in place to prevent an accidental missile firing such as had occurred with the US and Danish navies with Harpoon missiles in the early 1980s.

Gun Debate: The Oto Melara 76-mm gun was the chosen upgrade over the Bofors 57-mm gun, that had been selected for the CPF Project. There was some criticism over this in the Navy. The TRUMP PMO and Litton researched and assessed the capabilities of the two guns as being fairly similar in their ability to destroy air targets. Essentially, the water-cooled 76-mm was a "small big gun," while the air-cooled Bofors was a "big small gun." However, Oto Melara also offered to buy back the original 5-inch guns, and therefore was able to offer better value competitively.

Conclusion

The Canadian Navy received state-of-the-art area air-defence ships as a result of TRUMP. The Block 2 Standard Missile system had not been exported to any other country at the time, but the US Government had good confidence in the Canadian industrial ability to integrate, trial and operate this top-of-the-line suite, and allowed Canada to purchase the US equipment as a direct sale instead of through Foreign Military Sales (FMS). The upgraded *Iroquois*-class DDGs would go on to serve as flagships for Canadian fleet commanders for the next 20 years of service.

Cdr (Ret'd) Tony Thatcher is the Executive Director of CNTHA, and was the TRUMP Combat Systems Manager from 1985 to 1988.

Name	Pennant	Commission	TRUMP	Paid Off	Homeport
Iroquois	280	1972-07-29	1992-07-03	2015-05-01	Halifax
Huron	281	1972-12-16	1994-11-25	2005-03-31	Esquimalt
Athabaskan	282	1972-09-30	1994-06-04	2017-03-10	Halifax
Algonquin	283	1973-11-03	1991-10-11	2015-06-11	Esquimalt

Displacement:	5,100 tons full load
Dimensions:	128.92 x 15.24 x 4.42 metres
Propulsion:	2 shafts and variable-pitch propellers;
	2 x 570 KF cruise gas turbines, 12,788 shp
	2 x FT4A boost gas turbines, 51,000 shp;
	29 knots
Crew:	285
Aviation:	Helicopter deck with hauldown system
	Two CH-124 Sea King helicopters
Command & Control System:	Federated SHINPADS bus system with standard computers
	AN/UYK-501 and displays
Radar:	AN/SPQ-501 (Signaal DA08) air/surface search
	AN/SPQ 502 (Signaal LW08) air search
Sonar:	SQS-510 hull
	SQA-502 VDS
Fire Control:	two AN/SPG 501 (Signaal STIR 1.8)
	one Lightweight Radar and Optronic Director
EW:	SLQ-501 intercept
	SLQ-503 jammer
	4 x 6-barrelled Plessey SHIELD IR/chaff
	Nulka hovering decoy system
	SLQ-25 Nixie
Armament:	29-cell Mk-41 VLS (SM Block 11A)
	76-mm/62 OTO Melara (Super Rapid) DP gun
	.50-calibre machine guns
	20-mm Phalanx CIWS Mod 1B
	two triple Mk-32 12.75-inch torpedo tubes firing Mk-46 Mod 5 torpedoes.


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