Sic Itur Ad Astra

Canadian Aerospace Power Studies

Volume 5

Wings of the Fleet:

50 Years of the Canadian Sea King

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Sic Itur Ad Astra: Canadian Aerospace Power Studies

Volume 5
Wings for the Fleet: Fifty Years of the Canadian Sea King

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Preface

An aircraft can hold a unique place of honour within the history and culture of an air force. It is the physical representation of the thousands of men and women, both in and out of uniform, who have, through their ties to the aircraft, served their nation. Stories surrounding the aircraft—whether good or bad, perhaps told with either an emphatic curse or gleeful chuckle—remind us of a shared heritage and bonds that go far beyond mere wings, rotors, engines and electronics. Aircraft are, in a very real sense, "one" of us and have become part of our lives. Such is the case with respect to the CH124 Sea King.

For over five decades, the Sea King has flown in the service of Canada. At home and abroad, in peace and war, it has operated in some of the most unforgiving flying environments in the world, from the heat of Somalia to the frigid North Atlantic. It has rescued people from the sea, brought comfort to earthquake survivors, battled drug smugglers, dealt with prairie floods and Canadian ice storms and has been sent on combat operations four times since 1990—not bad for an aircraft rapidly approaching "senior citizen" status!

In doing so, it has lived up to the two mottos it has flown under: Ready Aye Ready and Sic Itur Ad Astra. It began its service as part of the Royal Canadian Navy (RCN) and proved beyond the shadow of a doubt that large, heavy helicopters could operate from "small-deck" destroyers. Not everyone was happy with the "forced marriage" between naval and air-force flight organizations that was brought about by unification, but we became stronger as a blended family. Indeed, the Sea King has spent more time as an Air Force "bird" than it did in the livery of the RCN. Still, it is sad to realize that our last tangible link to RCN naval aviators will be lost when the Sea King is stood down.

Therefore, it is important that we ensure that the stories associated with the Sea King, the aircraft and its people, are collected for future generations. This volume of *Sic Itur Ad Astra*, featuring papers delivered at the Canadian Forces Aerospace Warfare Centre's 2012 Air Force Historical Workshop, is a welcome addition to the historiography of this remarkable aircraft.

I hope you enjoy the read.

K. P. Truss
Colonel
Commanding Officer
Canadian Forces Aerospace Warfare Centre

Introduction

W. A. March

And now the end is near
And so I face the final curtain,
I'll state my case of which I'm certain.
I've lived a life that's full, I traveled each and ev'ry highway,
And more, much more than this. I did it my way.[1]

Although a bit tongue-in-cheek, Frank Sinatra's rendition of "My Way" would make a fitting ode to the Canadian CH124 Sea King helicopter. First acquired in 1963, I seriously doubt that anyone at that time thought that this particular aircraft would still be providing yeoman service to Canada more than 50 years later. Yet, it is and will probably be operational for a few more years—as we slowly, but surely, bring its replacement, the CH148 Cyclone, up to speed.

This volume of the *Sic Itur Ad Astra* series is dedicated to the Sea King. While it may seem unusual to some that a publication dedicated to exploring air power from a Canadian perspective should focus on a specific aircraft, the employment of this particular airframe over the years reflects a fundamental reality. The Royal Canadian Air Force (RCAF), regardless of its *nom de jour*, has rarely had sufficient resources to acquire specialized equipment to meet all of its roles and missions. Although the central element of *Air Force Vectors* speaks to "an agile and integrated air force with the reach and power essential for CAF [Canadian Armed Forces] operations,"[2] perhaps the wording should have included something along the lines of "making do with the resources at hand." This is certainly true with respect to a helicopter such as the Sea King, which has "soldiered on," despite the shifting political sands of Canadian defence policy.

In 1963 few could have imagined the world we live in today. The Union of Soviet Socialist Republics (USSR) was considered our primary threat, and participation in the North Atlantic Treaty Organization (NATO) and the North American Air Defence Command (NORAD) was the major element of our defence policy. Peacekeeping contributions to the United Nations (UN), although ongoing for several years, would only take on official prominence with the release of the 1964 *White Paper on Defence*.[3] Constant reference was made throughout the document of the need to have strong fixed- and rotary-wing antisubmarine warfare (ASW) components in support of domestic and alliance defence requirements. Indeed, the *White Paper* emphasized the need to invest funds to "maintain a relatively constant improvement of maritime anti-submarine capability."[4] I am sure that when the drafters of the *White Paper* wrote "constant" they were thinking of maintaining a capability rather than a specific airframe.

By the 1970s, détente between East and West was in the air, and the focus of the Canadian government had shifted from our principal alliances to utilizing the Department of National Defence (DND) for domestic purposes. In addition to being utilized to promote national development, the number one priority as outlined in *Defence in the 70s* (the White Paper on defence promulgated by Liberal Minister of National Defence Donald S. Macdonald) was the protection of Canadian sovereignty.[5] This was not a new role for Canada's military, but the increased emphasis placed on it by the government of the day resulted in a make-do attitude within the recently unified CAF. And although there are sections of the document that deal with the need to support NATO and NORAD, especially with respect to defending the United States nuclear deterrent, there is limited mention made of the ASW helicopter in this role. *Defence in the 70s* acknowledged the growth in the USSR's ballistic missile submarine force, touted the acquisition of four new helicopter destroyers (the venerable DDH 280s) but went on to state:

> Although an anti-submarine (ASW) capability will be maintained as part of the general purpose maritime forces, the present degree of emphasis on anti-submarine warfare directed against submarine-launched ballistic missiles (SLBMs) will be reduced in favour of other maritime roles.

> … This policy will take a long time to implement fully because of the life of current equipment, but it will govern both the acquisition of new equipment for the maritime force, and where applicable, modifications to existing equipment.[6]

For the Sea King community, still reeling from its "forced" divorce from the RCN, it was still part of Maritime Command, albeit in light versus dark blue. The raison d'être of the ASW helicopter was being de-emphasized, and although there was an office in place to determine a replacement for the helicopter, there were limited funds available.

Fast forward to the mid-1980s, and the Sea King's fortunes had changed somewhat. With the stand-up of Air Command in 1975, the Sea King was now part of a unified Air element, but it was still serving with Maritime Command. A Conservative Government was now in power, and Canada's defence and foreign affairs presence was undergoing a fresh look. In June 1987, a new defence White Paper was published. Entitled *Challenge and Commitment: A Defence Policy for Canada*, it redefined Canadian defence priorities, placing support for maintaining the Western strategic deterrent and contributions to credible conventional forces as the top two defence priorities of the Canadian government.[7] The document outlined an ambitious recapitalization of the CAF by acquiring new equipment and capabilities for all three elements. With respect to the Maritime element, attention quickly centred on the government's stated plan to acquire 10 to 12 nuclear submarines.[8] However, *Challenge and Commitment* also stated that additional surface ships would be acquired as well. They were to be equipped with "modern helicopters," as the Sea Kings had reached "the end of their useful life," and a selection process to identify and purchase "a new shipborne aircraft, to be produced in Canada" was ongoing.[9]

The replacement programme was quite advanced, and by August, the government announced European Helicopter Industries' EH101 helicopter had been selected as a replacement for the Sea King and that the company was moving ahead with the project definition phase. In the 1988–89 "Defence Update" presented to the House of Commons Standing Committee on National Defence in March 1988, the Government re-emphasized the antisubmarine and antiship role of the new maritime helicopter, but also allowed that the EH101 could have additional roles such as search and rescue as well as medical evacuation.[10] Then the wall came tumbling down.

The disintegration of the Soviet Union and the Warsaw Pact was dramatically portrayed on television screens though the jubilant dismantling of the Berlin War in 1989 and the reunification of Germany in 1990. National governments spoke of a brave new world with increased support for the UN abroad and a "peace-dividend" at home. The much-touted 1987 White Paper, already damaged beyond repair by cost and opposition to proposed programmes such as the acquisition of nuclear submarines, was discarded in favour of a more fiscally prudent defence document. In April 1992, Marcel Masse, the Conservative Minister of National Defence, released an update appropriately titled "Canadian Defence Policy." The document readily acknowledged that the freedoms associated with the removal of the Cold War paradigm brought with them a host of potential flash points, as nations no longer dominated by a Communist presence strove to balance a new sense of optimism with simmering ethnic, religious and territorial tensions.

Canada abandoned none of its traditional defence alliances. It merely reorganized its commitments to permit a gradual withdrawal of most of its European-based forces and a reorientation towards UN support. This was done not only in response to the changing international scene but also to address fiscal retrenchment at home.[11] The document clearly stated that the Canadian Forces (the "Armed" had been dropped by this point) would "have to adapt to new domestic realities and new geostrategic conditions" and it would do so from home, as its number one priority was "defence, sovereignty and civil responsibilities in Canada."[12] Still, the Sea King replacement contract remained untouched. And support for shipborne helicopters as part of Canada's maritime defence strategy remained strong.[13] Then came the 1993 federal election.

This particular election was unusual in that defence, or more specifically a piece of defence equipment, became one of the focal points of the event. Jean Chrétien, who would lead the Liberal party to a landslide victory, portrayed the Conservative-supported EH101 as an overly expensive "Cadillac," and one of his first acts upon becoming prime minister was to cancel the contract—with substantial penalties.[14] A year later, after public meetings and consultations, the "1994 White Paper on Defence" was released. While continuing with the policies of fiscal restraint and downsizing, it underlined the need for combat-capable forces, to fight "alongside the best, against the best."[15] This commitment included the provision of warships with appropriate maritime-air support. The now venerable Sea King helicopters were, once again, "approaching the end of their operational life" and work would, once again, "begin immediately to identify options and plans to put into service new affordable replacement helicopters by the end of the decade."[16] It was to be a long "decade."

The world was rocked by the terrorist attack on New York City on 11 September 2001. Canada quickly responded with the dispatch of land, air and maritime forces, including Sea King helicopters, to the Persian Gulf and Afghanistan in support of coalition operations. In 2004, a contract for the acquisition of 28 CH148 "Cyclone" helicopters was announced. A year later, the Conservative Government released *A Role of Pride and Influence in the World, Defence: Canada's International Policy Statement*. It spoke to the new reality of a global war on terror and an associated increase in defence spending to meet this new threat. Enhancement of the capabilities inherent within the three military services and special operations was a cornerstone of the policy statement. However, with respect to replacing the Sea King, the document blandly stated that it would be necessary to "complete the acquisition of new maritime helicopters."[17] Indeed, the 2008 *Canada First* Defence Strategy makes no reference to the Sea King or its replacement. It does speak of acquiring new ships to replace the ageing surface fleet that "will be fitted with different weapons, communications, surveillance and other systems" which can be assumed to include both the Sea King and, eventually, the Cyclone.[18] The end is in sight.

A long time coming, the CH124 Sea King celebrated its 50th anniversary in 2013 and will start "retiring" in 2015. The first Cyclones are at 12 Wing Shearwater, close to entering operational service. The end is indeed near, and although the final curtain is years away, there is no doubt that the aircraft—and the thousands of men and women who flew, maintained and were otherwise part of the Sea King legend—has made an important contribution to Canadian military and national history. Certainly the following papers, delivered at the 2012 RCAF Historical Workshop, will speak to some aspects of the helicopter's storied existence. In Canada and faraway lands, in peace and war, the Sea King has had a "full" life and, in a very literal sense, has travelled each and every highway. And despite the trials and tribulations of its existence, I am sure that if, for but a brief second, the CH124 Sea King had a voice, it would echo Frank Sinatra in proclaiming to the world that "I did it my way!"

Notes

1. Frank Sinatra, "My Way," by Paul Anka, recoded 1969 on *My Way*, Reprise Records. Quote from "Old Age Quotes," Notable Quotes, accessed February 10, 2015, www.notable-quotes.com/o/old_age_quotes.html.

2. Canada, DND, *Air Force Vectors* (Ottawa: Director General Air Force Development, 2014), v, accessed February 10, 2015, http://airforce.mil.ca/caf/vital/dairsp/afv_full_eng.pdf.

3. Canada, DND, *White Paper on Defence* (Ottawa: Queen's Printer, 1964), accessed February 10, 2015, http://publications.gc.ca/site/eng/429774/publication.html. Peacekeeping rated a one-page explanation (15–16) and was listed as the fourth out of five priorities (24) behind forces for the direct protection of Canada, forces-in-being for Europe, and maritime forces-in-being contributing to the overall Allied deterrent, but ahead of reserve forces and mobilization potential.

4. Ibid., 24.

5. Canada, DND, *Defence in the 70s* (Ottawa: Queen's Printer, 1971), 16, accessed February 10, 2015, http://publications.gc.ca/site/eng/429778/publication.html.

6. Ibid., 28.

7. Canada, DND, *Challenge and Commitment: A Defence Policy for Canada* (Ottawa: Queen's Printer, 1987), 49, accessed February 10, 2015, http://publications.gc.ca/site/eng/429765/publication.html.

8. Ibid., 52–55.

9. Ibid., 51.

10. Canada, DND, "Defence Update, 1988–89: Presented to the House of Commons Standing Committee on National Defence" (Ottawa: Queen's Printer, 1988), 9, accessed February 10, 2015, http://publications.gc.ca/site/eng/428867/publication.html.

11. Canada, DND, "Canadian Defence Policy" (Ottawa: Queen's Printer, 1992), 13–14, accessed February 10, 2015, http://publications.gc.ca/site/eng/429763/publication.html. All told, between 1989 and 1992, DND's budget had been reduced by almost $6 billion.

12. Ibid., 11.

13. Ibid., 21–22.

14. Michael Byers and Stewart Webb, "Five Decades, Two Contracts and Still No Helicopters for Canada," *The Globe and Mail*, February 11, 2013, accessed February 10, 2015, http://www.theglobeandmail.com/globe-debate/five-decades-two-contracts-and-still-no-helicopters-for-canada/article8435147/.

15. Canada, DND, "1994 White Paper on Defence" (Ottawa: Queen's Printer, 1994), Chapter 3, accessed February 10, 2015, http://publications.gc.ca/site/eng/430960/publication.html.

16. Ibid., Chapter 7.

17. Canada, DND, *A Role of Pride and Influence in the World, Defence: Canada's International Policy Statement* (Ottawa: Queen's Printer, 2005), 14, accessed February 10, 2015, http://publications.gc.ca/site/eng/273649/publication.html.

18. Canada, DND, *Canada First* Defence Strategy (Ottawa: Queen's Printer, 2008), 17, accessed February 10, 2015, http://publications.gc.ca/site/eng/370141/publication.html.

Chapter 1

The Influence of History on Sea Kings: The Development of an Antisubmarine Helicopter

John L. Orr

Introduction

The Sikorsky Sea King helicopter first flew on 11 March 1959 and continues flying around the world to this day in both military and commercial service—with no prospect of an early retirement. Having passed the golden jubilee of its first flight, it is appropriate to ask the questions, "How did the Sea King come to be, and what were the influences that led to its development?"

This paper attempts to answer those questions and is based on research being conducted for a history of the 50 years of the Sikorsky Sea King in Canadian military service which will be commemorated in 2013.

Gathering the information for this paper has been both easier and more difficult than I anticipated. Easier because the Internet has made available material that would otherwise have been inaccessible, and more difficult because the usual sources, government and company archives, have proven to be less accessible than I imagined.

Perhaps some of you may think that the title of this paper is somewhat familiar. It is, in fact, a play on the title of Alfred Thayer Mahan's famous work, *The Influence of Sea Power upon History*. Conceivably, a later, and much longer, paper should study the influence of Sea Kings upon history.

My intention is to show how the history of rotary-wing aviation influenced the development of the Sikorsky Sea King. I take a chronological approach through the various technical and doctrinal events of the past and mention some of the key personalities. It is a story of incremental advances and a few false steps leading, ultimately, to our end point, the introduction of the Sea King antisubmarine helicopter to the United States Navy (USN).

Along the way, we'll find some obstructionists who shared the sentiments expressed by Wilbur Wright about helicopters in a letter written in 1906:

> Like all novices we began with the helicopter, (in childhood) but soon saw that it had no future and dropped it. The helicopter does with great labor only what the balloon does without labor, and is no more fitted than the balloon for rapid horizontal flight. If its engine stops it must fall with deathly violence, for it can neither float like the balloon nor glide like the aeroplane. The helicopter is much easier to design than the aeroplane but it is worthless when done.[1]

And we will discover some visionaries; one is Lieutenant Commander W. G. Knapp, USN, who gave the following assessment of helicopters in antisubmarine warfare (ASW) in 1951:

> Even the most ardent enthusiasts of the helicopter-sonar ASW system are not rash enough to claim that this is the only answer. But we do believe that [it] is one answer and … the situation is so grave that no line of attack must be left unexplored.[2]

The Autogiro Era

To begin this study, I am not going to go back to the era of Leonardo da Vinci, generally acknowledged as one of the fathers of the helicopter. I would, however, take you back to the period between the First and Second World Wars and a Spanish inventor by the name of Juan de la Cierva—without a doubt the leading proponent of rotary-wing flight during this period.

De la Cierva's breakthrough came with the invention and development of the gyroplane, the first practical rotary-wing aircraft, in 1923. As a reminder, the gyroplane derives most or all of its lift from a freewheeling rotor and has a separate means of propulsion—usually a conventional aircraft engine and propeller. De la Cierva termed his gyroplane an "autogiro," and that is the name that is generally associated with this type of aircraft.

While not a true helicopter, the autogiro was an interim step which led to the resolution of many of the issues faced by the later helicopter pioneers. It was de la Cierva who:

a. invented the "flapping" rotor blade which eliminated a major source of instability in rotary-wing flight, caused by unequal lift across the rotor disc;

b. incorporated "drag hinges" (lead/lag dampers) on his flapping rotor blades, again to control instability;

c. invented the "tilting head" method of controlling rotary-wing aircraft, thereby establishing the principle that the most effective method of control of rotary-wing aircraft is achieved through the rotor and not aerodynamic forces; and

d. developed the "jump take-off" through which the rotor was brought up to a suitable speed by the engine and the autogiro achieved vertical flight—if only briefly.[3]

De la Cierva, a civil engineer, began his work in Spain but eventually shifted his efforts to the United Kingdom (UK) in 1925, where he established the Cierva Aurogiro Company Limited. Although based in the UK, through his licensees, de la Cierva had a profound effect on rotary-wing development in the United States (US) as well as Germany, Russia and even Japan.

In the US, the de la Cierva licensee, Harold Pitcairn, established the Pitcairn–Cierva Autogiro Company in Pennsylvania in 1929. One of their designs, the XOP-1, was ordered by the USN in 1931 and, on 23 September of that year, made the first take-offs and landings by a rotary-wing aircraft on board United States Ship (USS) *Langley.* Following further operations by the US Marines in Nicaragua in 1932, it was assessed that the autogiro did not demonstrate a significant advantage over the fixed-wing aircraft of the period.[4]

De la Cierva's most successful designs, the C.30 and the later C.40, were purchased by the Royal Air Force (RAF) in 1935 and incorporated both "direct control" and provision for a "jump take-off." With this latter capability, the autogiro achieved the facility to operate from small flight decks, such as those that could be constructed on board a ship. De la Cierva used such a flight deck on the Spanish seaplane tender *Delado* on 7 March 1934. This was followed by a demonstration of the C.30 on board the Italian cruiser *Fiume* in January 1935.[5] In 1936, de la Cierva was tragically killed in a fixed-wing aircraft accident, thereby ending a promising career in rotary-wing development.

In the meantime, another de la Cierva licensee, Focke-Wulf (Germany), had been experimenting with rotary-wing aircraft in Germany. Their famous engineer, Dr. Henrich Focke, made a major step forward when, following the flight of the first practical helicopter built by the Frenchman Bréguet-Dorand in June 1935, he and Gerd Achgelis developed the Focke-Wulf 61 (Fw-61) which first flew in June 1936. This helicopter incorporated a twin-rotor system mounted on lateral outriggers attached to a conventional airplane fuselage. The advantage of the twin-rotor design was that the blades rotated in opposite directions, and therefore, there was no need to counter the torque generated by the rotor system as there would be in a single main-rotor helicopter.

The Fw-61 quickly established itself as the pre-eminent helicopter of the day, easily surpassing the records set by Bréguet-Dorand and, importantly, demonstrated successful autorotations from powered flight.[6] The aircraft became famous, if not infamous, due to the flying demonstrations by the German female test pilot and ardent Nazi, Hanna Reitsch, in the Deutschlandhalle sports stadium in 1938.

By the late 1930s, practical rotary-wing flight had been in development for nearly 15 years. Much work had been done with autogiros, principally through the efforts of de la Cierva and his licensees. His developments to do with rotors (flapping and lead/lag hinges) and direct control as well as a method of achieving a jump take-off led the way for others to make the leap from autogiro to helicopter.

It is interesting to reflect that companies in Europe had taken the lead in rotary-wing development up until this point, a situation that was about to change radically due to the Second World War and American companies coming to the fore.

Dr. William Trimble, a noted chronicler of US naval aviation and the aviation industry of Pennsylvania, made the following observation about helicopter development during the Second World War in his book *High Frontier*: “Besides the turbojet engine, the helicopter was the premier technological development in aeronautics of the World War II period.”[7] It is important to note, however, that like the turbojet engine, the helicopter failed to make a significant contribution at the tactical level during the Second World War due to the length of time required to field a viable aircraft—it would take another conflict, the Korean War, to achieve that.

Interwar Period

In the US, Harold Pitcairn had extended his license for autogiros to the Kellett Autogyro Corporation, and both companies attempted to develop commercial and military markets for their aircraft.[8] Unfortunately, the Depression was in full swing and the market simply could not support the fledgling autogiro industry. In a move born of desperation, Pitcairn approached his member of Congress, Representative Frank Dorsey from Philadelphia, to sponsor a bill to provide US$2,000,000 to the War Department to buy autogiros for Army research and testing.[9]

To Pitcairn’s chagrin, the Army and Navy both opposed the funding, as their experience with autogiros had not been encouraging. Furthermore, as a result of expert testimony, the Dorsey Act was expanded to provide funding to the War Department not only for the development of autogiros but also “for the purpose of rotary-wing and other aircraft research, development, procurement, experimentation, and operation for flight testing.”[10] This opened the door, ever so slightly, for money to be spent on the development of a true helicopter. The Dorsey Act, as amended, finally passed into law, and the War Department became the centre of rotary-wing development in the United States.

Why the War Department alone was responsible for the disbursement of the Dorsey Act funds relates to the persistent indifference of the Navy Department towards rotary-wing aviation. The USN and particularly the Bureau of Aeronautics remained unconvinced that helicopters were a worthwhile endeavour, particularly as they had experienced poor results with autogiros and were heavily involved in lighter-than-air as well as fixed-wing aviation. Moreover, the Bureau of Aeronautics felt that the helicopter could never carry a sufficiently large payload.[11] The upshot was an interservice agreement signed in 1939 whereby the United States Army Air Corps (USAAC) was assigned the responsibility to develop rotary-wing aircraft. This would not be the last time that USN rotary-wing aviation would be stymied by internal obstruction.[12]

In addition to funding the purchase of rotary-wing aircraft, the Dorsey Act also permitted the Philadelphia Branch of the Institute of Aeronautical Sciences to hold a series of seminal meetings at the Franklin Institute concerning rotary-wing developments in 1938 and 1939.[13] The proceedings of these meetings are not readily available, but it would be interesting to review the presentation of Igor Sikorsky to the second conference in 1939 entitled “Commercial and Military Uses of Rotating Wing Aircraft.”[14]

Igor Sikorsky

Having mentioned Igor Sikorsky and since he has a central role in our story, we should briefly look at his career. Born in Kiev, he began his aviation exploits in Russia by experimenting with two helicopter projects in 1909—attempts that resulted in failure.

Following a brief but successful period of designing fixed-wing aircraft for the Russian Empire during the First World War, Sikorsky emigrated to the US during the Russian Revolution and, in conjunction with a group of fellow Russian émigrés, established a fixed-wing aircraft manufacturing firm, specializing in amphibious aircraft and culminating in the design and manufacture of flying boats for Pan American Airlines. While working on the development of his fixed-wing aircraft, Sikorsky continued to experiment privately with rotary-wing concepts and obtained a number of patents in this field.

By the 1930s, Sikorsky Aviation Corporation was part of the United Aircraft and Transport Company. After Sikorsky Aviation lost a military contract for a four-engine patrol bomber for the USN in 1938, Eugene Wilson, President of United Aircraft, summoned Sikorsky and informed him that the Sikorsky Aviation Corporation would have to be closed as they had no prospects for future contracts.[15]

Sikorsky accepted the decision with equanimity and suggested that he would like to return to the development of helicopters if United Aircraft would grant him research funding. This was agreed, and with a modest amount of seed money, Sikorsky began work on his first successful helicopter, the VS-300. It should be noted that United Aircraft did not have particular confidence in the future of helicopters, but they had great confidence in the genius of Igor Sikorsky. One can only speculate on what the influence on helicopter development would have been if Sikorsky had won the contract for an advanced patrol bomber.

Early Second World War

Through the funding provided by the Dorsey Act, the US Army had contracted in 1940 with another Pennsylvania-based company, Platt-LePage, to produce a helicopter, the XR-1, based on the Fw-61 design. Ultimately, this design would prove to be unsuccessful.[16] However, within days of the contract for the XR-1 being signed, Captain Franklin Gregory, the USAAC rotary-wing project officer, came to the Sikorsky plant to see the privately developed VS-300. He was most impressed with the capabilities of the helicopter and even had an opportunity to fly it.[17] When he returned to Dayton, Ohio, Gregory started agitating for the award of a contract through the Dorsey Act, and on 17 December 1940, a contract was let for an improved VS-300, the VS-316, later designated as the XR-4. This proved to be the first practical single-rotor helicopter and was ready for series production by the end of 1941—just as the US entered the Second World War.

Meanwhile, helicopter development in the UK had been brought to a halt by the outbreak of the Second World War.[18] However, the Royal Navy (RN) was interested in providing an embarked aviation capability to the embattled convoys in the North Atlantic Air Gap and purchased American autogiros to operate from merchant vessels modified to include a flight deck amidships.[19] In this role, the autogiro would perform the “scarecrow” function during daytime patrols, as it had neither sensors nor weapons. By detecting a German U-boat, the autogiro would force it to submerge and then notify the escorts of a potential threat to allow the convoy to sidestep the danger area. The autogiro never deployed operationally in this role, but as we shall see, it paved the way for the first tentative steps of the helicopter in ASW.

As the war progressed, the USN faced growing criticism over the rapidly rising number of shipping losses in 1942, principally due to the Navy’s reluctance to impose convoys when they entered the war in December 1941.[20] The USN eventually adopted the convoy system in May 1942, and while this greatly reduced the losses along the US East Coast, it did not address the pressing need to provide an embarked aviation capability to counter the U-boat wolf packs which had, by this time, shifted their focus back to the central North Atlantic where they were free from attack by shore-based Allied aircraft.

1943: The Year of Change

Sensing pressure to speed the development of the helicopter as an ASW platform, on 15 February 1943, Admiral King, the Chief of Naval Operations, assigned USN responsibilities for the development of the helicopter in ASW to the United States Coast Guard (USCG) which had come under the control of the Navy during wartime.[21] Despite the bureaucratic manoeuvring, in May 1943, the USN was called to account for the shipping losses by the press and, more importantly, the Truman Committee, a US Congressional oversight committee chaired by then

Senator Harry Truman. The committee urged the USN to examine the provision of helicopters to the hard-pressed merchantmen as they made their way across the North Atlantic.[22]

A practical demonstration of the capability of helicopters to operate from ships at sea took place 6–7 May 1943, when Captain Gregory of the US Army conducted landings and take-offs from a platform onboard the Steam Ship (SS) *Bunker Hill* in Long Island Sound under the watchful eye of Igor Sikorsky.[23] These trials demonstrated that even in its fledgling state, the helicopter was capable of conducting flight operations at sea. In a further move to deflect criticism of the USN, Admiral King next established the Combined (US/UK) Board for the Evaluation of the Helicopter in Anti-Submarine Warfare, also in May 1943, with representation of a host of agencies, including the US War Shipping Administration and a strong British delegation.[24]

As noted above, the responsibility for developing "naval" applications for the helicopter had passed to the USCG, which rose to the challenge of developing the helicopter with the tacit support of their senior leadership and the active efforts of three individuals—Commander (CDR) Kossler, Chief of the Aviation Engineering Division at Coast Guard Headquarters and the pilots Lieutenant Commander (LCDR) Erickson and Lieutenant, Junior Grade (LTJG) Graham. Kossler and Erickson led the charge against the entrenched bureaucracy of the USN Bureau of Aeronautics through whom the USCG had to deal. They were keen to develop the helicopter as a search-and-rescue (SAR) platform, and Erickson is credited with developing both the rescue hoist and basket. Recognizing that the USN was only interested in aircraft with a combat capability, Kossler and Ericson engaged in what has been termed "The Deception."[25] Rather than emphasizing the SAR role, they pressed for the employment of the helicopter as an antisubmarine weapon system in order to advance the overall state of the art of helicopter aviation.

Late Second World War

It was left to Graham to actually carry out the development of the helicopter as an antisubmarine platform through the incorporation of an airborne sonar, as will be related later. Before he worked on the dipping sonar, though, Graham was the senior pilot during the combined US/UK operational evaluation of two British R-4s onboard the SS *Daghestan* as she made her way to the UK in January 1944. The weather for the crossing was typically appalling, and during the 16-day transit, only two days were suitable for flying. It had to be conceded that this trial was a failure, and there were no further operational helicopter deployments at sea in the Atlantic during the Second World War.[26]

It should be noted that the US and the UK were not the only ones to consider the use of rotary-wing aircraft at sea. Anton Flettner, a German engineer and beneficiary of de la Cierva's pioneering work, developed a synchropter (a helicopter with intermeshing blades)—the Flettner 282—which was very successful. However, it failed to be fully developed because of the indifference of the Luftwaffe and the impact of the Allied bombing campaign.[27]

The deployment onboard the SS *Daghestan* had shown that the R-4 was seriously underpowered, therefore, Sikorsky proposed a new design, the R-5, in January 1944. This was a two-seat helicopter but with a tandem-seating arrangement, and production was eventually stalled both by technical challenges and the end of hostilities. Eventually, however, Sikorsky managed to adapt the design to become the HO2S (a two-seater), the HO3S (a four-seater) and the commercial S-51.[28] An improved R-4, the R-6 was introduced by Sikorsky just prior to the end of the war and was to later serve in the USN as the HOS. Intriguingly, manufacture of this helicopter was assigned to a different company (Nash-Kelvinator) so that Sikorsky could concentrate on rectifying the technical difficulties encountered by the R-5.

By the end of the Second World War, both Allied and Axis rotary-wing aviation had advanced from the autogiro to the true helicopter. Allied helicopter development was almost exclusively centred in the US. Despite the reluctance of the USN to invest in helicopters, the USCG pioneered the use of the R-4 to act as the "eyes and ears of the convoy"[29] at sea. This, along with a push from the US Army and the War Shipping Administration as well as significant orders from the UK, led to development of the Sikorsky R-5 and R-6 which promised to deliver what the R-4 had only hinted at.

While Axis development of helicopters roughly paralleled the developments in America, the impact of the Allied bombing campaign greatly impeded their manufacture and operational use.

Post-War to Korean War

Following the Second World War, much of the pressure to develop rotary-wing aviation fell by the wayside, and helicopter manufacturers found that they were facing an uncertain future. The USCG reverted to its peacetime status and returned to the fold of the Department of the Treasury. Even in the USCG, rotary-wing aviation was assigned a secondary priority, although some dramatic rescues by helicopter were performed.[30]

Fortunately, there was one area that remained a priority, and that was the use of the helicopter in ASW. The need for a new approach to ASW can be attributed to the fact that developments in the German U-boat fleet at the end of the Second World War—such as the snorkel and particularly the Type XXI U-boat—had threatened to upset the Allies' overwhelming technological advantage, and there was every expectation that this technology had fallen into the hands of the Soviet Union when they occupied East Germany.

Work had begun in the spring of 1945 to install and test a prototype airborne sonar, the Hayes Sound Recording System, in an HOS-1. Test flights were carried out in the vicinity of Coast Guard Air Station Brooklyn as well as from the USCG Cutter *Cobb*, a converted freighter. The results were promising, and accordingly, in March 1946, Commander Graham of the USCG reported to VX-1 in Key West to commence trials with an HOS helicopter and the new Hayes XCF dipping sonar. Just to follow this thread for a moment, Graham was later involved in the trial of the Bendix AN/AQS-4 in a Piasecki HRP during February 1951. This was a more complex trial and evaluated the use of helicopters in an ASW screen in the place of destroyer escorts. Finally, in August 1952, trials were conducted to evaluate the AN/AQS-4 sonar fitted in an HO4S-1.[31]

Later that year, the first USN ASW helicopter squadrons, HS-1 and HS-2, were formed on the East and West coasts respectively in 1951 and 1952, but as will be seen, their aircraft were not up to the task.

Korean War and the Early Cold War

Once again a war, this time the Korean War, proved to be the spur to helicopter development. Despite the efforts expended to develop the helicopter as an ASW platform, the USN was more interested in developing the helicopter in a combat-support, rather than a true combat, role. By 1950, the HO3S routinely deployed as a rescue helicopter on board US aircraft carriers, battleships, cruisers and even tanks landing ships (LSTs).

While the UK sought to re-establish their rotary-wing industry after the war, the RAF and RN showed a distinct preference for US, and especially Sikorsky, designs, which were manufactured under license by Westland. The HO3S (Dragonfly) was only the first in a series of these British helicopters.[32]

By this time, the USN and specifically the Bureau of Aeronautics had overcome some of their reluctance to embrace helicopters and pursued a series of larger tandem-rotor designs developed by Frank Piasecki. A tandem-rotor configuration was considered superior, as it allowed for a large, unobstructed cabin without the centre-of-gravity (CG) problems associated with the single-rotor helicopters of the day such as the HO3S. The Piasecki HRP, and later the HUP, quickly developed many of the standard utility roles common to all maritime helicopters of today.

With the start of the cold war with the Soviet Union, there was renewed concern that in any future conflict at sea, the next Battle of the Atlantic would be a close-run thing. A series of internal USN studies culminated in an innovative approach to addressing the challenges faced in any future maritime struggle. A high-level study group, Project Hartwell, was established at Massachusetts Institute of Technology (MIT) in the summer of 1950 to examine the problem. The group produced a report which led to significant investment by the US government and industry in ASW. Among the various projects recommended by this study was the development of an ASW helicopter. In a prescient assessment that rings true even today, the following recommendation was made:

> The helicopter, as a vehicle invulnerable to torpedo attack, with a high search rate against submarines, the ability to operate with task forces, convoys, and fast independents, and to destroy submarines once contact is made, seems the most promising single weapon system for anti-submarine warfare. The development of a suitable all-weather vehicle, an improved sonar, and a weapon should be accelerated. Secure communications and station-keeping navigation should also be considered.[33]

So the search was on for an ASW helicopter—and this time, the USN and the Bureau of Aeronautics were onside. What followed was a confusing period where various helicopters were pressed into service in the ASW role—a role that they were not particularly suited for, as they had been designed for other purposes. There were three significant challenges that faced helicopter designers:

a. The requirement to operate the engine at high-power settings for prolonged periods of time in the hover and as the dipping sonar was lowered and raised.

b. The necessity to provide the pilots with stability-assist and automatic stabilization to reduce their workload—again especially in the hover.

c. The requirement to operate the helicopter in night and instrument meteorological conditions (IMC) and especially to transition from forward flight to a hover.[34]

Clearly, not all of these requirements could be met given the state of the art in the early 50s.

At this stage, there were two helicopters that were candidates to fill this requirement, the Sikorsky HO4S and the Piasecki HUP. The HO4S-1 was initially planned to meet a United States Air Force (USAF) requirement for an Arctic rescue helicopter. Sikorsky had rearranged the location of the engine and cockpit and managed to free up the cabin area to address the centre-of-gravity problems of earlier designs.[35] An impressive helicopter for the day, the HO4S was used extensively around the world in military and civilian configurations. As with the HO3S, this helicopter was also licensed for production by Westland for the RN and RAF as the Whirlwind and eventually became a test bed for the adoption of the gas turbine engine (Rolls Royce's Gnome) for helicopters. Unfortunately, in ASW trials, it soon became apparent that the USN's piston-engine HO4S-1 was underpowered for this role.

The USN then turned to the second competitor, the Piasecki HUP. However, the HUPs also proved to be underpowered for this task. The ASW equipment was soon removed, and the aircraft returned to utility duties. The USN then *returned* to the HO4S, and with the provision of an uprated engine, the HO4S-3 became the USN's interim ASW helicopter—albeit restricted to day / visual meteorological conditions (VMC).

A competition was opened by the USN in January 1950 for a purpose-built ASW helicopter as would be recommended by Project Hartwell, and in June of the same year, a contract was awarded to Bell helicopters for the tandem rotor HSL: a helicopter that only a mother—or an engineer—could love! Ultimately, this design failed its Navy acceptance for a variety of reasons, not the least of which was the excessive noise for the sonar operator in the cabin, the lengthy development process, the difficulty of folding the rotor blades at sea and problems associated with fitting it on the elevators of the aircraft carriers of the day. A fatal crash in April 1955 led to a cutback in the production, and the USN approached Sikorsky for a new ASW helicopter to follow the HO4S-3.[36]

Sikorsky reoffered the H-34 that they had initially proposed for the competition which Bell had won. They now pressed forward with what would become the HSS-1—another highly successful design for Sikorsky both militarily and commercially. However, it was still restricted to day / VMC conditions, although it was later modified, as will be explained below.[37] Once again in the UK, Westland manufactured this helicopter under license for the British Armed Forces as the Wessex, but building on their work with the Whirlwind, they incorporated a Napier Gazelle turbo-shaft engine.[38] It was to take Sikorsky another production cycle to reach this capability in American military and naval helicopters.

In one of life's little ironies, the HSS-1 entered fleet service in 1955, the same year that USS *Nautilus*, the world's first nuclear-powered submarine, became operational. The balance of ASW once again swung in favour of the submarine—some would say permanently. And it was not to be long before the Soviet Union developed nuclear-powered submarines.

As mentioned previously, one of the challenges faced by helicopter designers was the requirement to fly in night / IMC conditions and to transition to the hover. While automatic stabilization was available in the HSS-1 for several years, it was not until late 1958 that the HSS-1N acquired an automatic approach capability to transition into a hover—the infamous Sikorsky sleigh ride. When you consider that the initial "couplers" used to accomplish this were tube-technology, the achievement was breathtaking.[39]

Another challenge was the development of a suitable power plant, and in 1953, the USN let a contract to General Electric (GE) to develop a gas turbine engine specifically for helicopters. Designated the T-58, it met the requirement for a lightweight, powerful engine, capable of operating at high-power settings for prolonged periods of time.[40]

While the HSS-1N was a marked improvement over the HO4S-3, it still lacked the ability to perform the "single package" mission—that is, to hunt and kill the submarine from the same platform. With this in mind, in 1956, Sikorsky started preliminary design work on a twin-turbine, boat-hulled helicopter concept. Shortly afterwards, the USN issued a new competition for an improved ASW helicopter, and in September 1957, Sikorsky won the development contract. The first flight of the XHSS-2 was on 11 March 1959, and fleet deliveries began in September 1961.

The Sea King was, and is, a truly remarkable helicopter. In all, 1,473 Sea Kings were produced in various marks and models by Sikorsky and a variety of licensees.[41] More than 50 years later, many of them are still flying. A fitting tribute indeed to an amazing machine and all those who designed, built, flew, maintained and supported the old girl.

Conclusion

Returning to the questions posed at the beginning of this paper, I would offer the following conclusions about "The Influence of History on Sea Kings."

There were no "givens" in the development of the helicopter per se and, especially, the development of the helicopter in ASW. The process was evolutionary, lengthy and strongly influenced by wartime (especially cold war) requirements. In most cases, significant direct government funding was essential for improvements in capability, such as the development of the T-58 engine and a coupler capable of making an automatic approach to an ASW hover. Finally, the tepid support, if not negative influence, of the USN's Bureau of Aeronautics regarding the development of helicopters in ASW is striking. The process which eventually led to building the Sea King depended on the strong influence of legislation and agencies outside the Bureau of Aeronautics. As a reminder, these included the Dorsey Act, the USAAC, the USCG, the wartime Combined Board for the Evaluation of the Helicopter in Anti-Submarine Warfare and Project Hartwell.

All the more reason to pause and celebrate a remarkable aircraft as it passes the half-century mark and to reflect on the contributions of all those involved in this triumph of aviation.

Notes

1. Wilbur Wright and Orville Wright, *Miracle at Kitty Hawk: The Letters of Wilbur and Orville Wright*, ed. Fred C. Kelly (Cambridge, MA: Da Capo Press, 2002), 167.

2. W. G. Knapp, “Helicopters in Antisubmarine Warfare” (paper, Sixth Undersea Symposium, May 9–10, 1951), 5, Hathi Trust Digital Library, accessed September 3, 2011, http://babel.hathitrust.org/cgi/pt?id=uc1.31822035453844.

3. Peter W. Brooks, *Cierva Autogiros: The Development of Rotary-Wing Flight* (Washington, DC: Smithsonian Institution Press, 1988), 33.

4. Ibid., 133.

5. Ibid., 184.

6. J. Gordon Leishman, “Development of the Autogiro: A Technical Perspective,” *Journal of Aircraft* 41, no. 4 (July–August 2004): 777.

7. William F. Trimble, *High Frontier* (Pittsburgh, PA: University of Pittsburgh Press, 1982), 245.

8. “The Contributions of the Autogyro,” U.S. Centennial of Flight Commission, accessed January 10, 2014, http://www.centennialofflight.net/essay/Rotary/autogiro/HE3.htm.

9. Richard Whittle, *The Dream Machine: The Untold Story of the Notorious V-22 Osprey* (New York: Simon & Schuster, 2010), 17.

10. Ibid., 18; Leishman, 778; and Roger Douglas Connor, “Grasshopers and Jump Takeoff: The Autogiro Programs of the U. S. Army Air Corp,” 62nd Annual Forum Proceedings AHS International (Washington, DC: AHS International, 2006), 1661.

11. “R-4 Coast Guard,” Igor Sikorsky Historical Archives, accessed January 10, 2014, http://www.sikorskyarchives.com/R-4_Coast_Guard.php.

12. For a more complete discussion of the USN’s reluctance to support rotary wing aviation, see Roger Douglas Connor, “Downwash and Uproar: The US Navy’s Troubled Association with the Helicopter in World War Two.” 61st Annual Forum Proceedings AHS International (Washington, DC: AHS International, 2005), 1746–57.

13. Dr. Bruce H. Charnov, “The 1938 Franklin Institute Meeting: Evolution and Revolution in Rotary Wing Aircraft.” *Vertiflite* 53, no. 2 (Summer 2007): 50.

14. Whittle, 18; and Leishman, 778.

15. Eugene E. Wilson, *Slipstream: The Autobiography of an Air Craftsman* (New York: McGraw-Hill Book Company, Inc., 1950), 183–84.

16. Jay P. Spenser, *WhirlyBirds: A History of the U.S. Helicopter Pioneers* (Seattle, WA: University of Washington Press, 1998), 379.

17. Ralph P. Alex, “How Are You Fixed for Blades? The Saga of the Helicopter, Circa 1940–60,” in *Vertical Flight: The Age of the Helicopter*, ed. Walter J. Boyne and Donald S. Lopez (Washington, DC: Smithsonian Institution Press, 1984), 18.

18. Matthew Uttley, *Westland and the British Helicopter Industry 1945–1960: Licensed Production Versus Indigenous Innovation* (London: Frank Cass, 2001), 22.

19. Brooks, 187.

20. Samuel Eliot Morison, *History of United States Naval Operations in World War II* (Boston: Little, Brown and Company, 1947), 200.

21. “R-4 Coast Guard.”

22. Drew Pearson, “The Washington Merry-Go-Round,” United Feature Syndicate, 7 May 1943, accessed January 10, 2014, http://dspace.wrlc.org/doc/get/2041/20128/b05f11-0507zdisplay.pdf.

23. Colonel H. F. Gregory, *The Helicopter or Anything a Horse Can Do*, revised and edited by Squadron Leader W. J. D. Allan (London: George Allen & Unwin Ltd, 1948), 198.

24. "The Development of the Helicopter," Igor Sikorsky Historical Archives, accessed September 3, 2011, site discontinued, http://www.sikorskyarchives.com/tdoth.html.

25. LCDR Tom Beard USCG, (Retired), "The Deception: Helicopter ASW," National Naval Aviation Museum Foundation (Spring 1994): 83.

26. Robert M. Browning Jr., "The Eyes and Ears of the Convoy: Development of the Helicopter as an Anti-Submarine Weapon" (United States Coast Guard Historian, 1993), 13, accessed January 10, 2014, www.uscg.mil/history/articles/Helicopter.pdf.

27. Steve Coates, *Helicopters of the Third Reich* (Hersham, Surrey: Classic Publications, 2002), 87, 89.

28. Spenser, 383.

29. Browning.

30. Spenser, 412.

31. The paragraphs describing the development of the airborne sonar for helicopters are drawn from Stewart Ross Graham, "Wolfpack and Sunday Comics: The Birth of Anti-Submarine Warfare," USCG Aviation History, accessed January 10, 2014, http://uscgaviationhistory.aoptero.org/images/WOLFPACK_AND_SUNDAY_COMICS.pdf.

32. Uttley, 125.

33. Massachusetts Institute of Technology, "*Project Hartwell: A Report on Security of Ocean Transport"* Volume 1 of 2 (Boston: Massachusetts Institute of Technology, 1950), 4.

34. Knapp, 4–5.

35. Edward F. Katzenberger and Edward S. Carter, "The Technical Evolution of Sikorsky Helicopters, 1950–1983," in Boyne and Lopez, *Vertical Flight*, 196.

36. Tommy H. Thomason, *The Forgotten Bell HSL ASW Helicopter: Naval Fighters Number Seventy* (Simi Valley, CA: Ginter Books, 2005), 62.

37. Lennart Lundh, *Sikorsky H-34: An Illustrated History* (Atglen, PA: Schiffer Publishing Ltd., 1998), 104.

38. Ibid., 68

39. "Automatic Stabilization for Helicopters," *Flight and Aircraft Engineer* 2594, no. 74 (10 October 1958): 572.

40. "Model T58," General Electric, accessed September 3, 2011, site discontinued, http://www.geae.com/engines/military/t58/spotlight_history.html.

41. Thomas Lawrence, email to author, August 15, 2011.

John L. Orr

Colonel Orr (Retired) joined the Royal Canadian Navy in September 1963 and graduated in 1967 from the Royal Military College of Canada.

Selected for aircrew training, he began flying at Shearwater in 1969 and subsequently completed five operational tours on the Sea King helicopter, culminating in command of 423 Helicopter Anti-submarine Squadron from 1985–87.

A graduate of the Canadian Forces Command and Staff College, Colonel Orr (Retired) has held staff appointments at National Defence Headquarters, Air Command Headquarters and Maritime Air Group Headquarters.

Colonel Orr (Retired) was appointed as Canadian Forces Attaché in Cairo (1990–93) with accreditation to Egypt and Sudan. He subsequently served as Secretary to the Chief of Staff of Headquarters, Allied Forces Central Europe (1993–96) before returning to Canada in 1996 as the Deputy Commander, Maritime Air Group (MAG). With the disbandment of MAG in July 1997, Colonel Orr was appointed as the Maritime Air Component Commander (Atlantic) (1997–99).

In July 1999, Colonel Orr (Retired) went back to the Middle East as the Chief of Liaison with the Multinational Force and Observers in the Sinai. He returned to Canada and retired from the Canadian Forces in September 2000. He is currently a research fellow with the Centre for Foreign Policy Studies at Dalhousie University.

Chapter 2

"We Came To Mow Your Lawn": How and Why Canada Acquired the Sikorsky Sea King Helicopter

John L. Orr

Introduction

By the mid-1950s, the Royal Canadian Navy (RCN) was facing a profound dilemma. The launching of the nuclear-powered submarine United States Ship (USS) *Nautilus,* and the presumed ability of the Soviet Navy to duplicate this feat, put the surface warships of Western navies on notice that the balance of antisubmarine warfare (ASW) had shifted dramatically against them, some would say forever. Different navies responded to this dilemma in different fashions, but the response of the RCN was both innovative and unique. It included the fitting of new hull-mounted sonars, the development of a variable depth sonar (VDS) system and the marriage of a medium-sized helicopter with the newly commissioned destroyer escorts (DDEs) of the ST. LAURENT and succeeding classes.

It is this latter development that is the focus of this paper, and I will endeavour to explain how and, more importantly, why that happened. The so-called "DDH (destroyer helicopter carrying) concept"—a pioneering approach that vaulted the RCN and Canada to the forefront of maritime aviation—was to have a definitive impact on the tactical development of the Navy from the demise of the aircraft carrier Her Majesty's Canadian Ship (HMCS) BONAVENTURE in 1970 until the arrival of the HALIFAX class frigate with its passive towed array in the early 1990s.[1] The title of this paper, "We Came To Mow Your Lawn," comes from one of the interviews conducted as part of the Sea King History Project in preparation for the 50th anniversary of the Canadian Sea King which was marked in 2013. The quotation is key to this paper and will be explained in due course.

Historiography

The most authoritative study of the DDH concept is *Uncharted Waters* by Dr. Shawn Cafferky.[2] With unparalleled access to primary source material and an extensive academic background in the development of Canadian naval aviation during and after the Second World War, Cafferky carefully follows the twists and turns of the process that eventually led to the selection of the Sea King helicopter and its integration with the Canadian Navy's DDEs. Another important study is Stu Soward's two-volume "recollective history" of Canadian naval aviation, *Hands to Flying Stations*. It is principally focused on the aircrew side of fixed-wing aviation in the heady 25 or so years between the commissioning of the first Canadian aircraft carrier HMCS WARRIOR in 1946 and the decommissioning of her ultimate successor, HMCS BONAVENTURE, in 1970. There are several key insights into rotary-wing developments in the second volume.[3] Finally, *"Certified Serviceable": Swordfish to Sea King* is an excellent account of the maintenance side of the house during approximately the same period as that covered by Soward's two-volume history but has more detail on rotary-wing activities at Shearwater in both the RCN and Canadian Armed Forces eras.[4]

The Post-War RCN and the Balanced Fleet

In the immediate post-hostilities period, the RCN pursued its ambition to acquire a balanced fleet consisting of cruisers, aircraft carriers and fleet-class destroyers so that it would never again be forced into the role of the "sheepdog" Navy that it had played during the Battle of the Atlantic of the Second World War. The impetus for the RCN to acquire aircraft carriers was the poor performance of the Canadian escort groups during the latter phases of the Battle of the Atlantic, caused in some measure by the lack of embarked Canadian aviation forces. It was to address this deficiency that the RCN, in 1943, sought and was eventually granted permission to provide the ship's companies for the escort carriers His Majesty's Ship (HMS) *Nabob* (ex-USS *Edisto*) and HMS *Puncher* (ex-USS *Willapa*) in the final years of the Second World War.[5] Plans for the Pacific campaign even saw the possibility that the RCN would acquire two additional light fleet carriers, but these came to naught due to the abrupt end of hostilities.[6]

In accordance with its post-war vision of a balanced fleet, the RCN convinced the government to allow it to develop a Canadian naval air branch centred on HMCS WARRIOR with an air group that included fighters (Seafires) as well as fixed-wing ASW aircraft (Fireflys).[7] The development of a peacetime aviation capability in the RCN required an agreement between the Royal Canadian Air Force (RCAF) and the Navy regarding the concept of operations for the fledgling Naval Air Branch. This was drawn up and signed in 1946 and would prove to be a continuing source of friction between the two services until the arrival of unification in 1968 and the demise of HMCS BONAVENTURE in 1970.[8] Under the terms of the 1946 agreement, the RCAF assumed responsibility for all shore-based RCN Air Branch activities while the RCN was responsible for embarked operations.[9] As we shall see, the agreement would have an important impact on the development of the helicopter as an ASW weapon system in the RCN.

It is intriguing to note that at this time the most experienced senior officer in Canada with respect to naval air operations was not in the RCN. It was, in fact, the Chief of the Air Staff (CAS), Air Marshal Robert Leckie, who had served as "commander air" in two Royal Navy (RN) carriers (*Hermes* and *Courageous*) before the Second World War. Small wonder then that the arrangement that he proposed to define the RCN/RCAF relationship replicated the dual control arrangement between the Royal Air Force and the RN of the period between the First and Second World Wars.

The Type XXI Submarine and the Emerging Threat

Modern ASW began at the end of the Second World War.[10] It included developments such as the use of radar at sea (both airborne and ship borne) as well as improvements in hull-mounted sonars, sonobuoys and magnetic anomaly detection equipment. In the final months of the Battle of the Atlantic, so great was the technological advantage enjoyed by the Allied ASW forces that German U-Boats were pursued relentlessly in the broad reaches of the North Atlantic. And yet, as the Battle of the Atlantic wound down, the victors were unsettled due to the arrival on the scene of the German Type XXI submarine which incorporated a larger battery, a hull with hydrodynamic characteristics and, most importantly, a snorkel; all of which had the potential to render the Allied ASW forces virtually impotent—if the Type XXI could have been deployed in sufficient numbers.[11]

After the war ended, it was generally acknowledged that as the Soviets advanced across Eastern Europe into what was to become East Germany, some of these submarines and their designers would fall into the hands of the Union of Soviet Socialist Republics. After all, that is precisely what happened on the western side of the Iron Curtain during the same period.[12] The prospect was that in any future conflict between the Soviets and the West there would be a "Third Battle of the Atlantic" which was expected to have many of the characteristics of the Second World War Battle of the Atlantic.[13]

ASW Specialization

The RCN, despite a valiant effort to maintain the balanced-fleet option, gradually gave up its post-war ambitions due to the grinding influence of greatly reduced post-war budget allocations.[14] It is hard to escape the conclusion offered by Dr. Tom Axworthy that "[t]he principal objective of the military [post-1945] was simply survival."[15] The last hurrah of the balanced-fleet concept occurred when RCN destroyers were deployed to the Korean War[16] along with the less well-known (and ultimately unsuccessful) attempts to have MAGNIFICENT (the replacement for WARRIOR) with her embarked air group assigned for duties in the same conflict.[17]

By the late 40s, the RCN was shifting its emphasis towards a more specialized ASW role.[18] In large measure, this was due to the threat the emerging Soviet submarine force posed to the sea lines of communication between North America and Europe and had to be addressed within the context of a steadily deteriorating strategic environment.[19] As early as 1948, the Chief of the Naval Staff (CNS), Vice-Admiral Grant, told the Cabinet Defence Committee that the main role of the RCN "was generally considered to be an anti-submarine one."[20] The Minister, Brooke Claxton, expressed a similar sentiment in the House of Commons when he stated that:

> At sea, our roles would largely consist [of] guarding the lines of communication as the RCN did so well during the last war. Canadian ships would be called upon to provide the vital protection for troops and supplies traveling the Northern seas our sailors knew so well.[21]

Within the RCN, it was appreciated that modern ASW DDEs were key to the successful prosecution of any future ASW campaign. By June 1949, the contract for the ST. LAURENT class DDEs was let for three hulls. These were among the first of the post-war DDEs of Western navies (and perhaps the best designed) and were planned specifically to deal with the emerging Soviet submarine threat based on the German Type XXI submarine.[22] In the same year, the durable Grumman Avenger replaced the RCN's original ASW aircraft, the Fairey Firefly. So by 1950, the RCN was preparing to face the cold war at sea, a struggle that would continue for the next 40 years and eventually lead to the acquisition of the Sea King helicopter by the RCN.

Helicopters in the RCN

Helicopters were introduced into the RCN on 1 September 1951, when No. 1 Naval Helicopter Flight, equipped with three Bell 47s (HTL-4s), was established at HMCS SHEARWATER.[23] These helicopters were principally intended to support the RCN's Arctic patrol vessel, HMCS LABRADOR, in her Arctic endeavours, which began shortly after she was commissioned in 1954. In this capacity, the Bells performed ice reconnaissance duties and supported survey operations ashore in addition to the usual utility roles. While at SHEARWATER, the helicopters provided search-and-rescue services, pilot training and a variety of fleet-support duties.

On 29 April 1952, No. 1 Naval Helicopter Flight acquired a Sikorsky HO4S-2 for plane guard duties in HMCS MAGNIFICENT. By 6 May, operations onboard MAGNIFICENT had taken place and two more helicopters were added later in that same year.[24] In a general redesignation of air squadrons at SHEARWATER to conform to the United States Navy (USN) system, No. 1 Helicopter Flight became VH 21 in November 1952.[25]

Returning to LABRADOR for a moment, during her four cruises to the Arctic in '54, '55, '56 and '57, her embarked helicopters performed yeoman service, particularly during her last three cruises when she was heavily involved with escorting the shipping for the construction of the Distant Early Warning (DEW) Line.[26] While LABRADOR's flight deck was larger than the American *Wind* class upon which her design was based, she was not initially fitted with a hangar, a deficiency that was eventually rectified and a lesson learned for the future.[27] Stu Soward quotes Lieutenant Bill Maxwell, LABRADOR's Air Engineer during the cruises of '54 and '55, about the impact of LABRADOR's cruises on future developments as follows:

> HMCS *Labrador* had a short commission in the RCN, but her design features had a great influence on this aspect of … Naval Aviation. … *Labrador* and her small teams of aviation maintenance personnel … initially set the standards of maintenance and technical support for small ship helicopter operations. … This established a pool of experienced aviation personnel including both pilots and technicians, thereby forming a basis for future application and the eventual development of the RCN DDH, a new helicopter carrying antisubmarine class of ship.[28]

Based on experience gained in LABRADOR's first Arctic operations, the RCN's helicopter fleet expanded to include the Piasecki HUP-3, accepted in May 1954 and deployed for the 1955 Arctic cruise. A larger helicopter with a tandem-rotor configuration, it nevertheless presented significant challenges both in its flying characteristics and its maintenance requirements.[29]

In April 1955, VH 21 was redesignated Helicopter Utility (HU) 21 and retained its responsibilities to support helicopter activities in LABRADOR and MAGNIFICENT afloat as well as a host of fleet-support roles while ashore. By this time, HU 21 was operating three different helicopter types, the Bell HTL-4, the Piasecki HUP-3 and the Sikorsky HO4S-2. Squadron aircrew maintained proficiency on all three types, and the maintenance and supply organizations somehow coped with the headaches of a small number of multiple types of helicopter.

Naval Staff Studies and the Sea/Air Warfare Committee

The air staff in Naval Service Headquarters in Ottawa kept a close eye on the development of the helicopter in ASW in both the RN and USN, mainly through reports submitted by liaison staffs in London and Washington.

In 1953, a committee of the Naval Staff was formed to examine the role of helicopters in ASW while conducting operations from a ship.[30] The chairman of the committee, Commander Hook, the Deputy Chief of Aviation (Tactics) who was on loan from the RN, made the observation that while current helicopters were unsuited to the rigours of ASW at sea, they showed promise, especially in the hunter-killer role. He stated that the roles for the helicopter in the future could include:

a. augmenting the convoy screen;

b. extending the detection range of the convoy screen;

c. forming small barrier screens; and

d. shortening the time for A/S [antisubmarine] forces to reach a datum.[31]

Based on the recommendations of the Hook study, the Navy moved quickly off the mark and by 6 November 1953 had a submission before the Chiefs of Staff Committee requesting the formation of an antisubmarine helicopter squadron consisting of six Piasecki H-21 helicopters (presumably to operate off the carrier) that would be commissioned in early 1954.[32]

At the 17 November 1953 meeting of the Chiefs of Staff Committee, this submission failed to receive approval, and while this was fortuitous given the limitations of the Piasecki H-21, it relaunched the spat between the RCAF and the RCN over command and control of maritime aviation and the role of helicopters in ASW that was to continue for several years. In the discussion at the Chiefs of Staff Committee meeting, the CNS stated that the use of helicopters could be "a marked step toward making up the deficiencies in the lack of surface escorts"—a critical problem as the RCN struggled to meet the necessary force levels for DDEs requested by the North Atlantic Treaty Organization's (NATO) Supreme Allied Commander Atlantic (SACLANT).[33]

The CAS considered that the principle of using helicopters in a maritime role was excellent but that further experimentation and investigation would be necessary before maritime helicopter squadrons could be formed and effectively employed. He proposed that the RCN obtain helicopters for experimental purposes in this field. It was eventually decided that the RCN would not be given approval to form "an ASW helicopter squadron … but that a small provisional unit for test and experimental purposes could be formed subject to the necessary funds being made available from the naval budget."[34]

Around this time, the Chiefs of Staff Committee directed a subcommittee, the Sea/Air Warfare Committee, to carry out a study of the submarine threat to Canada. This was to be a root and branch study, much along the lines of Project Hartwell (1950) in the United States.[35] A Sea/Air Warfare Study Group was formed and, at the 16th Meeting of the Sea/Air Warfare Committee on 11 March 1954, was given the broad responsibility to make recommendations to the Sea/Air Warfare Committee concerning the protection of the sea lines of communication that were of interest to Canada from the submarine threat.

The deliberations of this study group became so acrimonious that an Army officer, Colonel Rothschild, was named as the chairman in June 1954. A reflection of the state of affairs is apparent in a memorandum to the Vice Chief of the Naval Staff (VCNS) in December 1954 from Captain Fraser-Harris, the senior RCN member—and a naval aviator. While praising the work of the chairman, he stated that "The report of the Sea/Air Warfare Study Group contains in its conclusions no fact that could justify the time that has been spent on its production."[36] He went on to recommend that:

> in the interests of both good inter-service cooperation in Canada and proper emphasis upon all the various threats which must be met; agreement must be reached regarding service responsibilities for meeting various threats and for providing the appropriate weapons to do so.[37]

He then added that "the advent of the helicopter now makes it mandatory for all maritime aviation units to be under one command."[38] The fat was truly in the fire, and a long-standing battle was underway. Unfortunately, the final report of the Sea/Air Warfare Study Group does not appear to have survived.

Helicopter Anti-Submarine Squadron 50

The Piasecki H-21, which had been considered for the RCN's ASW helicopter role, ran into development difficulties; therefore, the RCN had to consider an alternative platform for its new helicopter antisubmarine squadron. Rather than acquire the Sikorsky S-58 (HSS-1) which still had not been selected for the ASW role in the USN, the RCN opted for the Sikorsky S-55, HO4S-3, a later variant of the HO4S-2 already in service with HU 21.

On 4 July 1955, in accordance with the direction of the Chiefs of Staff Committee, Helicopter Squadron (HS) 50 was commissioned by the RCN as an experimental squadron to evaluate the role of the helicopter in antisubmarine warfare using the AN/AQS-4 dipping sonar with 100 feet [30.5 metres] of cable.[39] Of note, the sonar operators for this equipment were drawn from the fleet and reportedly, their skill at squeezing every last ounce of capability from the AN/AQS-4 was exceptional.[40]

After a period of shore-based exercises in 1955, the squadron initially embarked in HMCS MAGNIFICENT in April 1956 and began a series of evaluations designed to test the squadron's suitability in ASW operations at sea.[41] But the debates at the Chiefs of Staff Committee over the role of RCN helicopters in ASW were not over. A paper entitled "Control and Operation of Helicopters in the Canadian Services" was presented by CAS at the 585th Meeting of the Chiefs of Staff Committee on 21 November 1955. The upshot of this meeting was that an ad hoc committee was formed to consider and submit recommendations:

a. on the coordination of helicopter requirements by the three services;

b. as to whether such requirements can be standardized into a limited number of types;

c. from an investigation as to whether the recommended types can be manufactured in Canada under license;

d. on the centralization of the procurement of helicopters and associated equipment;

e. on the coordination of maintenance; and

f. on a joint system of basic training for helicopter pilots.[42]

Another significant matter concerned the control of ASW helicopters in maritime warfare. This issue was raised at the 586th Meeting of the Chiefs of Staff Committee on 5 January 1956 and was referred to the Sea/Air Warfare Committee with direction to "submit recommendations regarding responsibility for the operation and control of A/S helicopters."[43] The results of the deliberations on these issues would strongly influence the future of ASW helicopters for the RCN.

The Sea/Air Warfare Committee finally reported back to the Chiefs of Staff nearly two and a half years later in February of 1958 and concluded that "the ASW helicopter does have a role in maritime warfare"[44]—thus resolving a major bone of contention between the RCAF and the RCN. The roles of the ASW helicopter were broken down into ASW helicopters operated from naval vessels and ASW helicopters operated from shore bases in support of the joint RCAF/RCN maritime concept. Finally, the committee recommended that "the operation and control of ASW helicopters operated from naval vessels be the responsibility of the RCN."[45] And there matters were to rest for the next decade and a half.[46]

Trials in HMCS BUCKINGHAM

Returning to the East Coast once again, while HS 50 was embarked in the carrier, efforts were underway to examine the feasibility of operating an ASW helicopter from an escort-sized vessel. This led to trials on board HMCS BUCKINGHAM from September to December 1956 with an HO4S-3 flying from a platform mounted above the ASW mortar well. As a result of these trials (conducted by HU 21[47]), it was concluded that the HO4S-3 was entirely unsuited for this type of operation, and it was recommended that a Sikorsky HSS-1 (S-58) helicopter be made available for further evaluation on board a ship of the ST. LAURENT class. Another important conclusion from the BUCKINGHAM trials was that a hangar was required for operations over prolonged periods and that "the limiting factors on helicopter operations were not in the pilot's ability to land a small moving platform but rather on the ability to rapidly secure the helicopter to the deck."[48]

The final report of these trials is often cited as being the beginning of the DDH concept, but it was not so apparent to those involved. One of the pilots, John Hewer, who would go on to command HS 50 in the Sea King era, had the following assessment: "they fitted a flight deck on the back of BUCKINGHAM and we did little trials but you know—it was a simple task actually—it didn't prove anything particularly."[49]

While Hewer is being a bit self-deprecating, he is correct in the sense that there had already been several successful helicopter landings on board Her Majesty's Canadian Ships—some instigated by then Lieutenant-Commander (LCdr) Pat Ryan, the Executive Officer of ST. LAURENT and a naval aviator himself.[50] In January 1956, a Bell HTL landed on board ST. LAURENT, and this was followed by the landing of an HU 21 HO4S in May 1956. These evolutions used the shored-up mortar well covers as an improvised flight deck rather than a temporary flight deck as had been done in BUCKINGHAM.

ASW Trials in Key West, 1957

In the autumn of 1956, HS 50 ceased its ASW training at sea, removed its sonar equipment and deployed to Knob Lake in order to help the RCAF support the construction of the Mid-Canada Line in Labrador.[51] After their Arctic sojourn in late 1956, HS 50 then self-deployed to Key West in January 1957 for three months of ASW exercises with the USN and the new ST. LAURENT class DDEs of the RCN.[52]

The reason that HS 50 had to self-deploy was that MAGNIFICENT was not available. It was originally intended that she be returned to the RN in late 1956 in exchange for BONAVENTURE. However, these plans were promptly changed in the aftermath of the Suez Crisis. After a speedy restoring, MAGNIFICENT sailed at the end of December 1956 to transport the equipment of the Canadian contingent to the First United Nations Emergency Force (UNEF I) to Port Said and was eventually returned to the RN in 1957. This incident illustrated the vulnerability of the RCN Air Branch to a loss of its only air-capable platform—a situation that would be repeated during the BONAVENTURE refit and her eventual disposal.

In Key West, there were excellent submarine services available, and once again, landings were accomplished on the mortar well covers of the deployed Canadian ships.[53] The result of this period of trials indicated that:

> considerable tactical advantage can be obtained from the use of helicopters in that, in suitable weather, they have the capacity to improve the range at which lethal weapons can be launched, or improve the rate at which doubtful sonar or radar contacts can be investigated.[54]

Trials in HMCS OTTAWA

BONAVENTURE commissioned in Northern Ireland in January 1957 and arrived in Halifax in June of the same year. In October, she sailed in company with HMCS OTTAWA to the United Kingdom in order to further evaluate the operation of a helicopter from a ST. LAURENT class escort, as recommended by the BUCKINGHAM trials report. The flight deck originally fitted in BUCKINGHAM had been transferred to OTTAWA, and an RCAF S-58 (HSS-1) was embarked rather than an HO4S.[55]

This trial demonstrated the feasibility of operating an HSS-1 helicopter from a ST. LAURENT class escort in the North Atlantic. Once again, it was concluded that a hangar was essential.[56] In fact, the aircraft suffered so much corrosion damage that it required a special inspection by Pratt & Whitney Canada upon return.[57] Additionally, the trials indicated that "the pilot does not require any special skill or knowledge … in this particular application of helicopter operations."[58] It was recommended, that "in view of the favourable results of these trials and the tactical potential that can be afforded by a helicopter operational platform, installation be fitted to all ST. LAURENT and RESTIGOUCHE class escort vessels without further delay."[59]

Several improvements to the helicopter were also recommended, the most important being the installation of an instantaneous securing device. It can be seen that the trial reports were most enthusiastic, but it was to be several years and a change of helicopter type before the DDH era would commence with the at-sea trials of a Sea King in HMCS ASSINIBOINE.

Before we leave BONAVENTURE and HS 50, it is important to note that as a general rule, because of deck-spotting factors, either the Banshee fighters of VF 870 or the helicopters of HS 50 had to be left ashore when she sailed on exercises. This not only increased the pressure for moving the ASW helicopters to the escorts but also provided the impetus for the search for a second carrier. Also adding to the pressure to move helicopters to the escorts was the revolution in maritime warfare caused by the nuclear-powered submarine. As explained in the introduction to this paper, with a new fleet of post-war DDEs in the water and with more on the way, the RCN had to look for ways to improve their ASW capability. As we will see, the DDH concept was a unique Canadian answer to that challenge.

As experience grew in HS 50 with the HO4S-3, the limitations of this helicopter became apparent, not the least being its poor performance in high density-altitude conditions, its restriction to day, visual meteorological conditions as well as its inability to both "hunt" and "kill" a submarine at the same time. The Naval Staff attempted repeatedly over the years following the establishment of HS 50 to acquire the Sikorsky HSS-1 (S-58) as a replacement for the HO4S-3, but these attempts foundered on the ongoing doctrinal debates within the Sea/Air Warfare Committee regarding the role of the helicopter in ASW and the general reduction in budgets imposed by the Diefenbaker Government.[60] As mentioned above, the doctrinal logjam broke in February 1958, when it was agreed that the helicopter had a role in ASW and that "the operation and control of A/S helicopters operated from naval vessels be the responsibility of the RCN."[61]

DDH Concept

The role of the ASW helicopter in an escort-sized vessel was formally presented to the Canadian Naval Staff in a paper dated 18 August 1958.[62] In examining the utility of the helicopter in this role, it was noted that several NATO navies had already been employing helicopters for this purpose, principally from aircraft carriers. The main benefits to the ASW system of the escort were given as an extension to the ship's sonar system and weapon range. In this regard, the manned helicopter was compared to other advanced weapons systems such as the rocket or drone-launched torpedo or the manned weapons carrier.[63]

In the final part of the paper, an implementation plan was proposed. The helicopter recommended was the Sikorsky HSS-1N (an improved S-58 with a night dipping capability). A total of 38 helicopters were proposed in order to man 20 escorts of the ST. LAURENT, RESTIGOUCHE and MACKENZIE classes for a price of $41 million. Interestingly enough, two squadrons were to be equipped with these aircraft: HS 50 on the East Coast at Shearwater and HS 51 on the West Coast at Pat Bay.

This, then, was the true beginning of the DDH concept. Obviously, things did not come to pass as proposed. Nonetheless, it is amazing to see the vision embodied in this paper. It is also important to remember that there were two types of platforms available in the RCN to operate ASW helicopters—the carrier BONAVENTURE and the as-yet unmodified escorts. The requirement to replace the helicopters of HS 50 on the carrier were to cloud the escort-based antisubmarine helicopter issue as will be seen below.

Choosing the Helicopter: The Battle of Ottawa

The next twist of the story occurs in December 1958. As mentioned above, the Chiefs of Staff Committee had directed the services to combine their future helicopter requirements and choose one light helicopter along with the maximum of two medium-to-heavy helicopters. The RCN was happy to agree with the selection of the Bell 47 light helicopter for elementary training but did not support the choice of the Army and RCAF for a medium helicopter, the Vertol 107

(Voyageur and Labrador respectively.) The Navy's objection was that this helicopter was too large and too heavy for escort use; although, it met the staff requirement for an ASW helicopter. The Navy proposed that either the Kaman HU2K or the Sikorsky S-63-2 be chosen instead; although, neither helicopter was operational at the time.[64]

By January 1959, the Acting Chief of Naval Technical Services (Air) recommended that the Kaman HU2K be selected due to its simplicity and ease of blade folding as well as the fact that it was smaller and lighter than the S-63-2. In attempting to decide on which aircraft to choose, a major complicating factor was that neither aircraft was available in an ASW configuration. This led to a technical and statistical evaluation process, which was based on data supplied by the manufacturers.[65]

In a review of spending estimates projected for 1959/60, the Naval Board had to grapple with a reduced allocation handed down by Treasury Board. In communicating this decision, the Deputy Minister of National Defence indicated that several items had been held up for policy clearance at Treasury Board. One of these was helicopter procurement, which the Naval Board subsequently decided would have first priority—an indication of how determined the Navy was to have escort-based helicopters.[66]

By February 1959, plans were sufficiently defined, and the VCNS proposed to the CNS that the helicopter replacement programme proceed. He explained that:

> The requirement is based on the replacement of existing helicopters in the experimental squadron, fitting of helicopters in the ST. LAURENT class escorts by 1964/65, and subsequent fitting in RESTIGOUCHE, repeat RESTIGOUCHE, and succeeding ships. The ultimate requirement will be: 6 for HS 50; 20 for ST. LAURENT, RESTIGOUCHE and repeat RESTIGOUCHE class; and at least one each in succeeding ship plus pipeline and reserve for attrition.[67]

CNS supported the proposal, and in April 1959, a letter was forwarded to the Chairman of the Chiefs of Staff Committee seeking authorization to purchase approximately 40 aircraft of either the Kaman HU2K or Sikorsky S-63-2 type with delivery of the first aircraft in 1960.[68]

In September, the Vice Chiefs of Staff Committee reported back to the Chiefs of Staff Committee on the issue of a common medium-to-heavy helicopter for all three services. Their conclusion was that while the Vertol 107 met the requirements of the Army and RCAF, it did not meet the requirements of the RCN for an escort-based helicopter. The committee considered that the S-63-2 was "unnecessarily large and correspondingly expensive" and, therefore, strongly recommended that the RCN be equipped with the Kaman HU2K and the Army and RCAF with the Vertol 107 and that the same engines be used in both aircraft.[69]

The Chiefs of Staff Committee supported this recommendation, and the Minister was advised that the Bell light helicopter would be procured for the Army, Navy and Air Force, the Vertol by the Army and RCAF, and the Kaman by the RCN.[70] No objection was recorded, and the Navy prepared to accept the new aircraft. The Minister was requested by the Chairman of the Chiefs of Staff Committee in November 1959 to approve the programme outlined above with the modification that the RCN's initial order was to be 12 HU2K aircraft with no requirement as to type after that date although future procurement would remain in step with ship alteration.

Meanwhile, the RCN's HO4S fleet was encountering difficulties. As mentioned previously, three aircraft had been purchased in 1952 and were assigned to HU 21 for plane guard, pilot training and utility commitments. A further ten were procured in 1955 to equip HS 50 (six), to provide an additional helicopter to HU 21 and to add three attrition aircraft. By December 1959, three of the HO4Ss had been written off and authority was sought to purchase an additional three machines. This was rejected by VCNS based on uncertainty regarding an operational role for HS 50 with the HO4S-3. Subsequently, CNS stated that there was no intention to maintain HS 50 at a strength of six aircraft until re-equipped. The matter was, therefore, dropped for the time being.[71]

An intriguing insight into the inner workings of the staff is gained through a memorandum from the VCNS (Bidwell) to the Assistant Chief of Naval Staff (Air and Warfare) [Brock] expressing VCNS's concern (and that of the CNS) over a staff paper that stated that the Kaman HU2K would "not quite meet [the] RCN staff requirement."[72] It includes the rather blistering comment that "if after spending $16,000,000 to get 12 of these helicopters … they do not meet the staff requirement, the RCN is in an embarrassing position."[73] This memorandum marks the beginning of the doubts regarding the suitability of the HU2K.

The initial response of the staff was to calm the VCNS and CNS and to point out that no "off-the-shelf" helicopter met the RCN requirement. They also noted that, in time, a better machine than the HU2K could be produced if the RCN was willing to wait for it—a prophetic statement indeed. However, the conclusion was that time was paramount, and the Kaman would meet the necessary requirements.[74] This memorandum was followed in mid-May by a memorandum to CNS proposing a reduced or "interim" staff requirement, which the HU2K could meet. Finally, an omnibus submission to the Treasury Board was prepared, requesting authority to improve the ASW efficiency of the fleet by adding variable-depth sonars, long-range hull-mounted sonars and helicopters to current escort vessels.[75]

In their response on 23 June 1960, the Treasury Board indicated that while they agreed with the conversion of seven ST. LAURENT class escorts and HMCS CRUSADER[76] to accept helicopters, they felt that the decision to purchase HU2K helicopters was premature due to rapid developments which might make the HU2K obsolete and, thereby, necessitate another major purchase of an ASW helicopter in the near term. It was proposed that HS 50's HO4Ss could fill the gap until the situation stabilized.[77] This prompted a strong but polite reply from the Minister of National Defence in September reaffirming the Department's position that the HU2K was required.[78]

This reply was considered by the Treasury Board, and DND was advised in October that the Board was still not satisfied and requested re-examination of the proposed helicopter programme in light of the fact that the most pressing requirement was to replace HS 50's carrier-borne aircraft in 1963 and not to man the escorts, since they would not be ready until three or four years later. The Naval Staff apparently had not anticipated this split of requirements.[79]

Seasprite vs Sea King

This further rejection forced a re-examination of the situation with the result that the Navy stuck to its guns. The Treasury Board finally caved in and approved the Navy's procurement of 12 HU2Ks on 5 December 1960.[80]

In the same month, it was revealed that the price of 12 Kaman HU2K helicopters had escalated from $14.5 million to $21.5 million. It was, therefore, decided to re-examine the choice of helicopters. A final comparison was made between the HU2K (or CHSK as it was now known) and the HSS-2 (Sea King). The conclusion was that the CHSK did not appear to provide sufficient value for expenditure and that the HSS-2 had such advantages for the RCN escort role that it was worth a detailed examination. It was recommended that the Naval Staff do a further cost analysis and report within a month. It was also recommended that an examination of the changes to helicopter facilities required to accommodate the HSS-2 be proceeded with immediately.[81]

In response to this recommendation, a further study was undertaken, and it was suggested that the hangar / flight deck arrangements be changed to split the funnel uptakes to provide the increased room necessary to accommodate a Sea King. Thus, the improved ST. LAURENT and ANNAPOLIS classes of DDH took on their distinctive appearance.

By April 1961, it was evident that the HU2K was encountering significant difficulties during the United States Navy's Preliminary Evaluation. Chief among these was the helicopter's weight. This was particularly important since without a significant weight reduction, the helicopter could not begin to meet the RCN Interim Staff Requirement for an escort-based ASW helicopter.

By August, the Naval Policy Coordination Committee was advised of the current situation. In a very telling sentence, it was stated that: "The HSS-2 … shows great promise of being the most effective ASW vehicle of its kind." It was recommended that a final decision on the suitability of the HU2K be made within 30 days of the completion of the USN's Preliminary Evaluation.[82] The Naval Board agreed that the situation regarding the HU2K was precarious and that it would have to be re-examined based on the Preliminary Evaluation.[83] It was also agreed that HS 50 should be rearmed as soon as possible with a new helicopter[84] and that the facilities in the ST. LAURENT and ANNAPOLIS class ships be increased to accommodate an HSS-2.[85]

In October, a report on the suitability of the HSS-2 as a replacement for the HU2K was submitted to the Naval Board. It was concluded that the HSS-2, with minor modifications (such as power tail-pylon fold) and the addition of ship stabilization, could be maintained and operated from a DDE—despite concerns that the rapid securing and deck handling device would have to cope with "a load of 16,000 pounds [7,257 kilograms] [sic] versus 10,000 pounds [4,536 kilograms]."[86]

In November, steps to rearm HS 50 with 10 HSS-2 helicopters for the carrier role were finalized while the decision regarding the HU2K was pending. In the same month, a message was received from RCN liaison personnel in the United States that the HU2K did not perform adequately during the USN Preliminary Evaluation and would not proceed to the next stage.

We are fortunate to have available the recollections of Joe Sosnkowski, an RCN test pilot attached to the Vertical / Short Takeoff and Landing (V/STOL) department at Patuxent River, who was involved in the USN Preliminary Evaluation of the HU2K. He described a particularly harrowing flight when the sprag (one-way) clutch in the transmission failed:

> [We entered an] autorotation. [A] big tree came up in front of us, hopped over the tree, had very little left but used it all—and crashed. And the helicopter thrashed around, fell over on its right hand side and I tore the seat right out of it. So we lay there, we got out of it okay. I had to crawl back in to shut it off. But we lay there and finally they came to pick us up—then [we went to the] hospital.[87]

Sosnkowski then described the reaction of the occupant of the house who happened to be a shift worker:

> Well, he came out, there was a bit of blood around and these two people lying in his bushes and he came out, a shift worker, in his underwear. He asked me, "What are you doing here?" and I said, "Well, what does it look like, we came to mow your lawn!"[88]

As noted above, the difficulties experienced by the HU2K were passed, informally, to the Canadian Defence Liaison Staff in Washington who, in turn, relayed the information to Naval Headquarters in Ottawa. While this was not the final blow for the HU2K, it certainly was the straw that broke the camel's back.

Sosnkowski's assessment regarding the decision not to proceed with the order of the HU2K is quite straightforward: "Quite frankly, I am just delighted that somebody listened and they cancelled the contract because that helicopter, as far as I was concerned, was dangerous."[89]

CHSS-2

This left the way clear to proceed with procurement of the HSS-2 as the only alternative available. By December 1961, the decision to acquire the HSS-2 as the replacement for the HU2K was approved by the Naval Board, and a Treasury Board submission to rearm HS 50 with 10 HSS-2s was also prepared.[90]

The Treasury Board rejected the submission for HS 50 until it could be demonstrated that the HSS-2 was suitable for operations from the DDEs as well as the carrier. The Board did allow that one helicopter could be purchased, if necessary, to conduct destroyer feasibility trials. They also stated that the total RCN programme might warrant production in Canada and that this would have to be examined before a final decision was made.[91]

With the ball firmly back in the Navy's court, it was decided to agree to the Treasury Board request to conduct feasibility trials, and these were carried out at the Sikorsky plant on 16 April 1962 with a prototype hauldown system using a Sea King "loaned" by the USN.[92] The trial was successful, and the Treasury Board's concerns about the DDE helicopter programme were assuaged.[93]

The suggestion by Treasury Board to consider domestic production of the Sea King most likely came about at the behest of the Department of Defence Production. In a memorandum to VCNS, Commodore Welland, Assistant Chief of the Naval Staff (Aviation & Weapons), pointed out that he believed that "the big helicopter has a future." He estimated that with potential military and civilian sales, the market could be as large as 500 helicopters and would, therefore, be a practical endeavour for United Aircraft of Canada Limited (UACL).[94] While this was clearly an overestimate of the eventual market, it should be borne in mind that domestic production of a helicopter to meet the needs of a combined military and civilian market would likely be a persuasive argument in Cabinet.[95] And still the mills ground slowly. While the type of helicopter had been decided, the numbers had not been finalized.

Finally, on 26 September 1962, Treasury Board approved the purchase of eight CHSS-2 helicopters with the first four to be manufactured at the Sikorsky plant and the remainder to be assembled at the UACL plant in Longueil, near Montreal on the south side of the St. Lawrence River.[96] On 20 November 1962, the Minister of National Defence, the Honourable Doug Harkness, announced that the RCN was being equipped with "helicopters of the most modern type."[97] On 24 May 1963, in a ceremony held at the Sikorsky plant, Sea King 4001 was handed over to the representatives of the Royal Canadian Navy, LCdr Shel Rowell (Commanding Officer, VX 10[98]) and LCdr Ted Fallen. Finally, on 1 August 1963, the first two Canadian Sea Kings arrived at Shearwater,[99] thereby starting a saga that has not yet been finished.

Conclusion

In retrospect, the vagaries of the procurement process are evident in this account and should be borne in mind as the MH community faces the future. Intra-service, inter-service and inter-departmental rivalries all influenced, and sometimes impeded, the procurement of the Sea King.

The leap of faith that the RCN made in choosing the Sea King has been fully vindicated. In this case, choosing a platform still in its initial phase of operational deployment, but with significant growth potential, was the right answer. The Sea King's durability in continuing to fly operationally 50 years after its introduction is both a tribute to the robustness and flexibility of its design and to the skill and dedication of all those who maintained and supported the old girl—both in and out of uniform.[100]

Furthermore, it is hard to escape the conclusion that if you have trained your people well, you must have confidence in them when they make a recommendation on a difficult policy matter. From the role of the staff in Naval Service Headquarters in developing the DDH concept and recommending the purchase of the Sea King, to the part played by then Lieutenant Joe Sosnkowski in Patuxent River, the leadership of the RCN gave this principle more than just lip service.

Despite the problems encountered along the way, the vision of the DDH concept remains fully justified. If evidence for this conclusion is required, one need only look at a recent volume of *Jane's Fighting Ships*. Every modern destroyer, frigate and even corvette is equipped with a flight deck and a helicopter. Fitting evidence indeed!

The RCN, and later the Canadian Armed Forces, went on to lead the world in the operation of medium-sized helicopters from escort-class vessels—an achievement unmatched by any other military but largely unnoticed by either the Canadian public or even the Canadian Armed Forces. We need to toot our horn a bit, and the Sea King 50th Anniversary in 2013 provides us with that opportunity!

Annex A: Helicopter Specifications

Bell HTL-4

Description	Two-seat general utility helicopters
Engine	200 horsepower (hp) [149.1 kilowatts (kw)] Franklin 6V4-200
Performance	Maximum speed - 100 miles per hour (mph)[160.9 kilometres per hour (km/h)] Range - 300 miles [482.8 kilometres (km)]
Crew	Two pilots

Kaman HU2K (Seasprite)[101]

Description	High-performance all-weather utility helipcopter
Engine	One GE T-58-8B turbo-shaft engine
Performance	Maximum speed - 141 kts [261 km/h] Range - 580 nautical miles (NM) [1, 074.2 km] Service ceiling - 17, 400 feet (ft) [5, 303.5 metre (m)]
Crew	Two pilots, one crewman

Piasecki HUP-3, Piasecki H-21 and Boeing-Vetrol 107

Description	Medical evacuation and light cargo helicopter
Engine	One 550 hp [410.1 kW] Continental R-975-46
Performance	Maximum speed - 104 mph [167.4 km/h] Range - 340 miles [547.2 km] Service ceiling - 10,000 ft [3,048 m}
Accommodation	Crew of two and four passengers or three stretcher cases

Sikorsky S-55 (HO4S-3)[103]

Note: The HO4S -1 was a failed attempt by the USN to develop an interim ASW helicopter. Three HO4S-2 helicopters were initially acquired for HU 21 and were equipped with a 550 hp [410.1 kW] Pratt & Whitney R-1340 engine. These were eventually upgraded to HO4S-3s with the installation of the 700hp [522.0 kW] Wright R-1300 engine. Ten HO4S-3 helicopters were purchased for HS 50.

Description	Twelve-seat utility or antisubmarine helicopter
Engine	One 700 hp [522.0 kW] Wright R-1300
Performance	Maximum speed - 112 mph [180.2 km/h] Range - 360 miles [579.4 km] Service ceiling - 10,600 ft [3,230.9 m]
Accommodation	Pilot's compartment seats two side-by-side. Cabin located below main lifting rotors. Seats from seven to ten passengers. Can carry up to six stretchers which can be loaded by hydraulic power-oper ated hoist while helicopter is hovering.
Armament	Homing torpedo (Mk 43) or depth-bombs

Sikorsky S-58 (HSS-1) (Seabat)[104]

Note: This helicopter had a number of designations depending on the service that employed it and its role. In the RCAF, it was the S-58. In the US Army and Air Force, it was the H-34. In the USN, it was first the HSS-1 Seabat and then the SH-34G. When a night dipping capability was added, it was designated as the HSS-1N and then the SH-34J.

Description	Twelve-seat utility or antisubmarine helicopter
Engine	One 1,525 hp [1,137.2 kW] Wright R-1820-84
Performance	Maximum speed - 121 mph [194.7 km/h] Range - 255 miles [410.4 km] Service ceiling - 9,500 ft [2,895.6 m]
Accommodation	Pilot's compartment seats two side-by-side. Cabin located below main lifting rotors. Seats up to sixteen passengers. Can carry up to eight stretchers.
Armament	One homing torpedo (Mk 43) or depth-bombs

Sikorsky S-63-2 (Proposal)[105]

Description	Antisubmarine helicopter
Engine	Two T-58 turbo-shaft engines. (T-58-6 or T-58-8)
Provenance	Described in the reference as a "cut-down HSS-2 for RCN role."
Armament	Homing torpedoes or depth-bombs

Sikorsky S-65 (Proposal)[106]

Description	Antisubmarine helicopter
Engine	One or possibly two T-58 turbo-shaft engines
Provenance	Likely comparable to S-62 with flying-boat hull but probably with four-bladed main rotor derived from S-58. Possibly similar to four-bladed S-62 (Model S-62B) developed for the Indian Air Force. Smaller and approximately 2,500 pounds (lb) [1,134 kilograms (kg)] lighter than the S-63-2.
Armament	Homing torpedoes or depth-bombs

Sikorsky S-61 (Sea King) (HSS-2/CHSS-2 later CH124)[107]

Description	Antisubmarine helicopter
Engine	Two GE T-58-8B turbo shaft engines, 1,250 shaft horsepower (shp) [932.1 kW at the rotor head] each
Performance	Maximum speed - 160 mph [257.5 km/h] Range - 571 miles [918.9 km] (four hours) Service ceiling - 14,000 ft [4,267.2m] All-up weight - 19,100 lb [8,663.6 kg]
Accommodation	Two pilots side-by-side and two sonar operators
Equipment	AN/AQS-10 sonar, its transducer suspended by 250 ft [76.2 m] of cable as compared with the 100 ft [30.5 m] of cable carried by the S-55 (HO4S-3) helicopter
Armament	Four Mk 43 homing torpedoes and/or Mk 54 depth-bombs fitted with the release mechanism for a special weapon which was not authorized for Canadian Sea Kings.

Editor's note: To provide a complete history of Canadian maritime helicopters until the Sea King's 50th anniversary, the following are included.

Agusta Westland EH101 (Cormorant) - later designated AW101[108]

Description	Multi-role, new generation, medium/heavy helicopter
Engine	Three CT7-8E engines, 2,041 shp [1,522 kW at the rotor head] each
Performance	Cruise speed - 150 knots [278 km/h] Range - 750 NM [1,390 km] (six hours) Maximum gross weight - 34,392 lb [15,600 kg]
Accommodation	Two pilots and 38 passengers

Sikorsky H-92 (Cyclone)[109]

Description	Twin-engine, medium-lift helicopter
Engine	Two GE CT7-8A turbo-shaft engines, 2,740 shp [2,043.2 kW at the rotor head] each
Performance	Maximum speed - 151 knots [280 km/h]
	Range - 539 NM [999 km]
	Service ceiling - 15,000 ft [4,572 m]
	Maximum gross weight - 26, 500 lb [12, 018 kg]
Accommodation	Cabin area - 132 square feet [40 square metres]

Notes

1. I am grateful to Dr. Richard Gimblett for this observation made during the course of the 18th RCAF Historical Workshop, Wings for the Fleet: Fifty Years of the Canadian Sea King, held at 12 Wing Shearwater, 19–20 June 2012.

2. Michael Shawn Cafferky, *Uncharted Waters: A History of the Canadian Helicopter-Carrying Destroyer* (Halifax: Centre for Foreign Policy Studies, 2005). As the original edition is out of print, a second edition was published by the Centre for Foreign Policy Studies in 2012.

3. Stewart E. Soward, *Hands to Flying Stations: A Recollective History of Canadian Naval Aviation*, vol. 2, *1955–1969* (Victoria, BC: Neptune Developments, 1995).

4. Peter Charlton and Michael Whitby, ed., *"Certified Serviceable": Swordfish to Sea King - The Technical History of Canadian Naval Aviation by Those Who Made It So* (Ottawa: CNATH Book Project, 1995).

5. Roger Sarty, "The Ghosts of Fisher and Jellicoe: The Royal Canadian Navy and the Quebec Conferences," in *The Second Quebec Conference Revisited: Waging War, Formulating Peace: Canada, Great Britiain, and the United States in 1944–45*, ed. David B. Woolner (New York: St. Martin's Press, 1998), 156. Of note, HMS *Nabob* was paid-off in September 1944 following her torpedoing and HMS *Puncher* was transferred to the United States Navy in January 1946.

6. J. D. F. Kealy and E. C. Russell, *A History of Canadian Naval Aviation, 1918–1962* (Ottawa: Department of National Defence, 1965), 22.

7. Ibid., 47.

8. Nigel Brodeur, interview by John L. Orr, Sea King History Project oral history interview, 15 May 2012.

9. Kealy and Russell, 49.

10. W. A. B. Douglas, *The Official History of the Royal Canadian Air Force*, *Volume II*, *The Creation of a National Air Force* (Toronto: University of Toronto Press, 1986), Chapter 17.

11. Roger Sarty, *The Maritime Defence of Canada* (Toronto: Canadian Institute of Strategic Studies, 1996), 208.

12. Gary E. Weir, *An Ocean in Common: American Naval Officers, Scientists, and the Ocean Environment* (College Station, TX: Texas A&M University Press, 2001), 248.

13. For a discussion of the "Third Battle of the Atlantic" see Dr. Owen R. Coté, Jr., "The Third Battle: Innovation in the U.S. Navy's Silent Cold War Struggle with Soviet Submarines" (Chief of Naval Operations, Submarine Warfare Division March 2000), accessed January 13, 2014, http://www.navy.mil/navydata/cno/n87/history/cold-war-asw.html.

14. Michael Whitby, "Fouled Deck: The Pursuit of an Augmented Aircraft Carrier Capability for the Royal Canadian Navy - Part 1, 1945–1956," *Canadian Air Force Journal* 3, no. 3 (Summer 2010): 10.

15. Tom Axworthy, "Soldiers Without Enemies: A Political Analysis of Canadian Defence Policy 1945–1975" (PhD thesis, Queen's University, 1978), 41.

16. See Michael Whitby, "The Long Reach: The RCN and the Korean War," *Canadian Naval Review* 1, no. 4 (Winter 2006): 19–23.

17. Peter T. Haydon, "Sailors, Admirals and Politicians: The Search for Identity after the War," in *A Nation's Navy: In Quest of a Canadian Naval Identity*, ed. Rob Huebert, Fred W. Crickard, and Michael L. Hadley (Montreal: McGill-Queen's University Press, 1996), 227.

18. See Jan Drent, "'A Good Workable Little Fleet': Canadian Naval Policy, 1945–1950," in Huebert, Crickard, and Hadley, *A Nation's Navy*.

19. The Communist takeover of Czechoslovakia took place in February 1948, and the Berlin blockade occurred between June 1948 and May 1949.

20. Drent, 217.

21. Quoted in S. Mathwin Davis, "The '*St Laurent*' Decision: Genesis of a Canadian Fleet," in *RCN in Transition 1910–1985*, ed. W. A. B. Douglas (Vancouver: UBC Press, 1988), 191. It was the threat to the "Defence of Trade" that provided the impetus for the American Project Hartwell in 1950, a seminal study in post-war ASW development sponsored by the USN which strongly influenced the development of ASW helicopters. See, John L. Orr, "The Influence of History on Sea Kings: The Development of an Anti-Submarine Helicopter" (paper, 18th Annual Royal Canadian Air Force Historical Workshop, Wings for the Fleet: Fifty Years of the Canadian Sea King, 12 Wing Shearwater, June 19–20, 2012).

22. Davis, 196.

23. Kealy and Russell, 55.

24. Charlton and Whitby, 56–57.

25. VH stands for heavier-than-air (V) and helicopter (H).

26. We are fortunate to have contemporary accounts of the helicopter aspects of the '55, '56 and '57 cruises. Bob Murray has written extensively about both the '55 and '57 cruises. See Robert Murray, "Canada Aviation Museum Aircraft: Piasecki (Vertol) HUP-3 (Retriever), Royal Canadian Navy (RCN)," (Ottawa: Canada Aviation and Space Museum, n.d.), accessed January 13, 2014, http://www.aviation.technomuses.ca/Assets/Pdf/E_Piaseckihup-3.Pdf. Don MacNeil has drawn upon his father's records (LCdr John MacNeil, Officer-in-Charge of HU 21 Detachment 2) to produce an as yet unpublished account of the '56 cruise.

27. Bob Murray, interview by John L. Orr, Sea King History Project oral history interview, 6 December 2011 and email exchange with author.

28. Soward, 291.

29. Dan Munro, interview by John L. Orr, Sea King History Project oral history interview, 26 May 2011; Gord Foster, interview by John L. Orr, Sea King History Project oral history interview, 22 March 2012; and Murray interview.

30. Cafferky, 106.

31. "First Progress Report of Committee on RCN Requirements for A/S Helicopters," Appendix A, The Role of Helicopters in ASW, NSS 1115-39 (Staff), 5 May 1953, Record Group (RG) 24 83-84/1967, vol. 11, file 1115-39, vol. 1, Library and Archives Canada (hereafter LAC). As quoted in Cafferky, 107.

32. "The RCN of the 1970 Era" n.d. (presumably 1962) Directorate of History and Heritage (DHH) 86/377. This file contains a useful survey of material related to ASW helicopter development. The detail mentioned here is contained in Chiefs of Staff Committee Minute 549-2, 17 November 1953.

33. Cafferky, 127. See also Minutes of the 549th Meeting of the Chiefs of Staff Committee on 17 November 1953, Chiefs of Staff Committee (CSC) 2-1 21 November 1955, 73/1233 files 1308-1309A, DHH.

34. Cafferky, 127.

35. See endnote 21 for comments on Project Hartwell.

36. Memorandum to VCNS, Report on the Sea/Air Warfare Study Group, 18 December 1954, LAC. I am indebted to Colonel Brian Akitt (Retired) for digging this material out of the archives at LAC.

37. Ibid.

38. Ibid.

39. John McDermott recalls that the "experimental" nature of HS 50 was only in the mind of the beholder. There was no need to convince the RCN of the concept, and he added that, "I was under the impression that we had to prove to the Air Force that it worked." John McDermott, interview by John L. Orr, Sea King History Project oral history interview, 26 October 2011.

40. Munro interview.

41. Charlton and Whitby, 82.

42. Minutes of the 585th Meeting of the Chiefs of Staff Committee on 21 November 1955, CSC 2-1, 21 November 1955, 73/1233, files 1308-1309A, DHH.

43. NSS 1270-78-1, 28 February 1958, LAC.

44. Ibid.

45. Ibid.

46. "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377. The detail mentioned here is contained in "Brief on ASW Helicopters in the RCN."

47. HU 21 was chosen since HS 50 was embarked and there was a chronic shortage of helicopter-qualified personnel in VX 10, a situation that was to continue for several years.

48. The detail mentioned here is contained in "Brief on ASW Helicopters in the RCN," in "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377. See also "Final Report on COMOPVAL Project Staff/SE 18 Helicopter Trials HMCS BUCKINGHAM."

49. John Hewer, interview by John L. Orr, Sea King History Project oral history interview, 30 April 2010.

50. See also Captain D. P. Ryan RCN (Retired), "Small Boys and Whirly Birds," *United States Naval Institute Proceeding* 96, no. 2 (February 1970).

51. Kealy and Russell, 69. HS 50 was eventually replaced in this task by HU 21. Munro recalls the cold.

52. Both Hewer and Munro mentioned this deployment, especially cruising along Miami Beach at 200 ft [61 m].

53. Munro interview.

54. "Brief on ASW Helicopters in the RCN," in "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377.

55. While there is no evidence to support this conclusion, it is likely that this arrangement was facilitated by the assistance provided in the fall/winter of 1956 by the helicopters of HS 50 and HU 21 to the RCAF in support of the construction of the Mid-Canada Line in Labrador.

56. "Brief on ASW Helicopters in the RCN," in "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377. See also "Final Report on COMOPVAL Project Staff/SE 42 Helicopter Trials – HMCS OTTAWA," Shearwater Aviation Museum.

57. Cafferky, 259.

58. Ibid.

59. Ibid., 260.

60. "Brief on ASW Helicopters in the RCN," in "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377. See also Minutes of the 541st Meeting of the Naval Board 4 September, 1957, Item 541-3, "Procurement of Helicopters."

61. NSS 1270-78-1, 28 February 1958, LAC.

62. "The Integration of Helicopters as Part of a Ship's ASW System," Enclosure A to NSS 1115-39 (Staff) 18 August 1958, signed by Captain Paul F. X. Russell, Director Undersea Warfare.

63. In the USN, the rocket-launched weapon became Weapon Alpha and then ASROC (Anti-Submarine ROCket) and the drone helicopter became DASH (Drone Anti-Submarine Helicopter). In the RN, the manned weapon carrier became the Westland Wasp helicopter, known as the Manned Torpedo-Carrying Helicopter (MATCH). The RCN was alone in considering a dual-purpose (search and attack) helicopter for the escort role, although the RN did use the Westland Wessex III from their *County* class cruisers.

64. The Kaman HU2K was designed to meet a USN requirement for a fast utility helicopter. It was a single rotor, single-engine (T-58) design. "Kaman SH-2 Seasprite," Wikipedia, accessed January 13, 2014, http://en.wikipedia.org/wiki/Kaman_SH-2_Seasprite. The S-63-2 was a twin-engine derivative of the single-engine S-62 Sea Guard acquired by the US Coast Guard and one of two "paper" helicopters proposed by Sikorsky to meet the RCN's requirement. The other was the S-65, apparently a considerably smaller helicopter. Source: RCN NSS 7801-102 (STAFF) 18 June 1959. "Comparison Study Kaman HU2K and Sikorsky S-63-2." See Annex A for helicopter specifications.

65. Naval Staff Committee (NSC) 7801-102 (Technical Staff [TS] Air) 5 January 1959, "Selection of an ASW Helicopter to Operate from RCN Escort Ships," DHH.

66. Paragraph 9, 584th Meeting of Naval Board, 14 January 1959, DHH.

67. NSS, 1115-39 S.D. 672 (Staff) 5 February 1959, "Integration of the ASW Helicopter into the Fleet," DHH.

68. NSS, 1115-39 (Staff) 10 April 1959, "Helicopters for Anti-Submarine Warfare," DHH.

69. CSC 10.9, 13 November 1959, "Procurement of Helicopters," DHH.

70. Ibid.

71. "Brief on ASW Helicopters in the RCN," in "The RCN of the 1970 Era" n.d. (presumably 1962) DHH 86/377, 8 December 1959 entry.

72. NSC 7801-102 (Staff) 17 December 1959, "ASW Helicopters."

73. Ibid.

74. NSC 7801-102 (Staff) 18 December 1959, "ASW Helicopters."

75. NSS 1115-39 (Staff), n.d., copy forwarded to Deputy Minister 24 May 1960, DHH.

76. CRUSADER was a "C" class destroyer which incorporated several ASW improvements including an experimental variable depth sonar.

77. Treasury Board letter, 23 June 1960, DHH.

78. Note on File (NOF) 23451 Minister of National Defence letter, September 1960, DHH.

79. NOF 23451 TS 566257-1, 5 October 1960, DHH.

80. NOF 23451 TS 566257-1, 5 December 1960, DHH.

81. Naval Staff (NS) 7820-102 (Staff), 18 January 1961, "ASW Helicopter Procurement." See also "Minutes of a Meeting Held in Director Naval Staff Room (DNSR) on Wednesday, 18 January 1961 to discuss Requirements in Ships to Carry the HSS-2 A/S Helicopter," 18 January 1961, DHH.

82. NSS 7820-102 (Staff), 14 August 1961, "ASW Helicopter Procurement – DDE Programme," DHH.

83. NSS 1279-65-1, 23 August 1961, "Minutes of the 657th Meeting of The Naval Board," Item 657-1 RCN Helicopter Procurement Programme, DHH.

84. NSS 7820-102 (Staff), 14 August 1961, "Accelerated Replacement of Carrier-Borne ASW Helicopters," DHH.

85. NSS 7820-102 (Staff), 17 August 1961, "A/S Helicopter Programme – DDE Programme," "Accelerated Replacement of Carrier-Borne ASW Helicopters" and "DDE Increased Aviation Facilities," DHH.

86. NSS 7801-102, 6 October 1961, "The Suitability of the CHSS-2 as an Alternate Choice for ASW Operations from Destroyer Escorts," DHH. The all-up weight (AUW) of a Sea King was 19,100 lb [8,664 kg] not 16,000 lb [7,257 kg].

87. Joe Sosnkowski, interview by John L. Orr, Sea King History Project oral history interview, 18 May 2011.

88. Sosnkowski interview.

89. Sosnkowski interview. Of note, the HU2K would eventually pass its US Navy Preliminary Evaluation and perform admirably first as a utility helicopter, particularly in combat search and rescue duties during the Vietnam War, and later as the airframe for the Light Airborne Multipurpose System (LAMPS) ASW helicopter.

90. NSC 7801-102 (Staff), 8 December 1961, “The Suitability of the HSS-2 as an Alternate Choice for ASW Operations from Destroyer Escorts,” DHH.

91. NOF 25532 (DGA) TB 590367, 16 January 1962, DHH.

92. Cafferky, 295.

93. Ibid., 296.

94. NS 7820-102 (Staff), 22 January 1962, “Helicopter Procurement,” DHH.

95. As an aside, it has been confirmed that the RCAF, which had acquired the Vertol 107 (Labrador) in about the same period as the Sea King, became disenchanted with this helicopter and entered exploratory talks with UACL to replace the Labrador with the Sea King. Ross Lennox, interview by John L. Orr, Sea King History Project oral history interview, 4 December 2011.

96. Cafferky, 298.

97. 307/62 HQ [Headquarters], 20 November 1962, “Statement by the Hon. Douglas Harkness, Minister of National Defence,” Helicopter file, DHH.

98. X stands for experimental or test.

99. 4001 and 4002 were flown from Patuxent River to Shearwater on 1 August 1963. 4003 remained at Patuxent River for instrumentation prior to trials in ASSINIBOINE, and 4004 was flown back to the Sikorsky plant for the installation of mission-related equipment.

100. As John Madower, an aerospace engineer with many years of experience maintaining the Sea King, pointed out, “the Sea King was designed using a slide rule” so there are inherent safety margins built into the aircraft. John Madower, interview by John L. Orr, Sea King History Project oral history interview, 9 December 2011.

101. “Kaman SH-2 Seasprite.”

102. Kealy and Russell, 140.

103. Ibid.

104. “Sikorsky Product History,” Igor Sikorsky Historical Archives, accessed January 13, 2014, http://www.sikorskyarchives.com/S-58%20%20HELICOPTER.php.

105. RCN NSS 7801-102 (Staff) 18 June 1959. Comparison Study Kaman HU2K and Sikorsky S-63-2. RCN NS 7820-102 (Staff) 18 January 1961, “ASW Helicopter Procurement.”

106. Kenneth H. Sullivan and Larry Milberry, *Power: The Pratt and Whitney Canada Story* (Toronto: CANAV Books, 1989), 234; and RCN NS 7820-102 (Staff), 18 January 1961, “ASW Helicopter Procurement.”

107. “Sikorsky Product History S-61 (HSS-2),” Igor Sikorsky Historical Archives, accessed January 13, 2014, http://www.sikorskyarchives.com/6W%20S-61%20(HSS-2).php.

108. “AW101 Technical Data,” AgustaWestland, accessed January 13, 2014, http://www.agustawestland.com/product/aw101-1.

109. “H 92 Helicopter,” Sikorsky, accessed January 13, 2014, http://www.sikorsky.com/Products/Product+Details/Model+Family+Details/+Details?provcmid=bfa955f4a9d98110VgnVCM1000001382000aRCRD&mofvcmid=7a8bebb600e98110VgnVCM1000001382000aRCRD&mofid=6a8bebb600e98110VgnVCM1000001382000a____&movcmid=92386d890c7b8110VgnVCM1000001382000aRCRD&moid=82386d890c7b8110VgnVCM1000001382000a____.

John L. Orr

Colonel Orr (Retired) joined the Royal Canadian Navy in September 1963 and graduated in 1967 from the Royal Military College of Canada.

Selected for aircrew training, he began flying at Shearwater in 1969 and subsequently completed five operational tours on the Sea King helicopter, culminating in command of 423 Helicopter Anti-submarine Squadron from 1985–87.

A graduate of the Canadian Forces Command and Staff College, Colonel Orr (Retired) has held staff appointments at National Defence Headquarters, Air Command Headquarters and Maritime Air Group Headquarters.

Colonel Orr (Retired) was appointed as Canadian Forces Attaché in Cairo (1990–93) with accreditation to Egypt and Sudan. He subsequently served as Secretary to the Chief of Staff of Headquarters, Allied Forces Central Europe (1993–96) before returning to Canada in 1996 as the Deputy Commander, Maritime Air Group (MAG). With the disbandment of MAG in July 1997, Colonel Orr was appointed as the Maritime Air Component Commander (Atlantic) (1997–99).

In July 1999, Colonel Orr (Retired) went back to the Middle East as the Chief of Liaison with the Multinational Force and Observers in the Sinai. He returned to Canada and retired from the Canadian Forces in September 2000. He is currently a research fellow with the Centre for Foreign Policy Studies at Dalhousie University.

Chapter 3

Seasprite to Sea King: The Royal Canadian Navy's Ship-borne Antisubmarine Helicopter Capability

Jason Delaney

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One of the better-known achievements of the post-war Royal Canadian Navy (RCN) is the integration of the large Sikorsky Sea King antisubmarine helicopter into small surface escorts. Of this, "radical and entirely Canadian development," Tony German writes that it was, "hugely admired" by other navies and that, "[a]fter eight years' development Canada's navy on its own brought a whole new dimension in anti-submarine [sic] warfare to the navies of the world,"[1] yet the remainder of his publication, *The Sea Is at Our Gates*, pays little deference to this accomplishment.

Understandably, there is very little mention of it in the final chapter of *A History of Canadian Naval Aviation* because Kealy and Russell were still writing while the helicopter/destroyer concept was being developed. What is more curious is that the proceedings of successive naval history conferences do not cover the topic sufficiently or at all. Both *RCN in Retrospect* and *RCN in Transition* barely cover the development of helicopter destroyers while *A Nation's Navy* and *People, Policy and Programmes* have no historians addressing this supposed great Canadian achievement.[2]

The centennial history published in 2010 has three authors who briefly discuss the subject within the context of challenges faced during the early-cold-war period, while Marc Milner provides one of the best, albeit short, descriptions in *Canada's Navy: The First Century*.[3] The fact remains, however, that despite the Sea King becoming an iconic workhorse serving on board Canadian warships for over half a century, only a few authors have contributed significant research to this development. Part of the reason lies in the fact that the Sea King came into service just as the naval-records system collapsed during the tumultuous period of headquarters integration and reorganization in 1964. Another part of the reason is because, until recently, many of the official records were classified.

The few authors who have managed to piece together significant material on the subject include: Peter Charlton, a former naval officer and aviation engineer with the experimental test squadron, Experimental Squadron 10 (VX 10), who contributed to *Certified Serviceable* with Michael Whitby and who wrote *Nobody Told Us It Couldn't Be Done: The VX10 Story*; Stuart Soward, author and former naval aviator, who produced a two-volume recollective history of Canadian naval aviation titled *Hands to Flying Stations*; and Aaron Plamondon who wrote *The Politics of Procurement* using the Sea King acquisition and the New Ship-borne Helicopter Project as the basis for a case study. Undoubtedly, however, the seminal work on this topic was done by Sean Cafferky, who is largely responsible for opening a great deal of the classified material. As a result, his publication, *Uncharted Waters*, is the first full treatment of the development of the ship-borne antisubmarine warfare (ASW) helicopter in Canada.[4] Although the above mentioned work pays considerable attention to the development of the concept in the mid-1950s and the integration of the Sea King into the fleet, it does not take it as far as the first operational tour at sea when the capability was ultimately proven. This is the goal that will be pursued herein, and it will be explained within the context of the larger allied ASW effort.[5] In the end, it will be shown that the marriage of the large ASW helicopter and the small surface escort, although a significant contribution to maritime warfare, was neither a radical development nor a dramatic change in antisubmarine warfare; it was simply a matter of necessity and only one example of many in which a limited ASW Navy struggled to keep up with the fast pace of technological advancements during the cold war.

First, it must be understood that developments in submarine and missile technology during the 1950s contributed to significant changes in maritime warfare. Over a relatively short period of time, contemporary weapons, sensors and tactics were considered inadequate, causing what has been referred to as the ASW crisis of the mid-1950s.[6] The world's first nuclear-powered submarine, USS (United States Ship) *Nautilus*, demonstrated that it could operate with relative immunity against the best efforts of modern ASW forces. The unique propulsion system, although noisy, allowed *Nautilus* to operate independent of the surface as well as run fast and deep to avoid detection. When discovered, *Nautilus* was difficult to track and most surface forces could not close the distance to launch their weapons; if they did, then they were at risk of a deadly counter-attack. This innovation in propulsion systems—along with other advancements such as new hull designs, sensors, fire control systems and noise reduction techniques—allowed the submarine to evolve as a weapons platform, making them faster, quieter and more deadly. Conventional submarines also had certain advantages. Although dependent on the surface for air, they could run slowly and silently or simply lie and wait, making them very difficult to detect with anything other than active sonar. Combined with advances in missile technology and the inevitable integration of these weapons into submarines, cold-war maritime warfare took on a whole new challenge during this period.

Then, in January 1956, the Chief of the Soviet Directorate of Naval Education Institutions, Admiral L. Vladimirsky, openly discussed the potential of the guided missile-firing submarine within the Soviet press.[7] This was followed by the First Secretary, Nikita Khrushchev, announcing to the world that his navy would focus their future development on guided-missile submarines because they were the most suitable naval weapons for attacks against the United States.[8] The idea that the Soviets had this capability—combined with indications that their submarines would increasingly be engaged in "blue-water" instead of defensive coastal operations—was disconcerting.[9]

Around this same time, the RCN established the Naval Warfare Study Group to investigate ways to better align defence planning with the North Atlantic Treaty Organization's (NATOs) new Military Committee (MC) 48 strategy that identified extensive Soviet submarine operations in the Atlantic as the "principle [sic] naval threat."[10] This study group was one of many influences recommending a shift in defence planning that would bring forces closer to the continent, along with a change in focus toward new antisubmarine concepts.[11] This paralleled much of the thinking within the United States Navy (USN), and joint exercise scenarios between the RCN and USN began to encompass both contemporary convoy protection as well as the defence of North America against missile-firing submarines.

Although the RCN was considered one of the best ASW navies at the time, it struggled to keep up with these advances. Michael Whitby identifies the problem perfectly in his biographical article on one of the more colourful senior officers in the RCN at the time—Captain A. B. F. Fraser-Harris. As the commanding officer of the aircraft carrier Her Majesty's Canadian Ship (HMCS) MAGNIFICENT, he wrote a report after a series of exercises in early 1956 that was critical of the state of the fleet with respect to antisubmarine warfare. In it he remarks that "our confidence in the ability of the surface ship to protect a screened body against attack, even from a contemporary submarine under controlled conditions, was sadly misplaced."[12] Fraser-Harris goes on to conclude that it was unrealistic to use the ships either in the hunter-killer role or in defence against missile-firing submarines. Notwithstanding relative success against German U-boats during the latter part of the Second World War, the age of the surface escort seemed at an end unless a way could be found to reduce the tactical advantage of the modern submarine. The small escort-type ships of the RCN needed a system that could range out with great speed and not only detect and localize but also destroy a submerged contact.[13]

By this time, many of those concerned with maritime defence began to acknowledge that the ASW helicopter was becoming increasingly more important to the future of antisubmarine warfare.[14] A respected defence scientist at the time went so far as to say that:

> With the advent of nuclear-powered submarines, the anti-submarine [sic] helicopter assumes an added importance. Because of its ability to search underwater and its relatively high speed as compared to even a nuclear-powered submarine, the helicopter's effectiveness should not be affected very much by the new development [nuclear submarines].
>
> In this respect, it is much more favourably placed than either the fixed-wing aircraft or the surface craft, and would appear an essential complement to them. Given adequate developments and a suitable vehicle, it seems likely in fact that some of the functions of both fixed-wing aircraft and escort vessels could be more efficiently performed by the anti-submarine [sic] helicopter.[15]

Subsequently, the helicopter was seen as having a large potential in the fighting role, and its value only increased when considering its relative invulnerability to counter-attack from a submarine. With this understood, the Naval Warfare Study Group recommended an increase in the RCN's ASW helicopter force to 40 aircraft by 1960.[16]

The problem was that ASW helicopters needed support facilities at sea, such as those found on-board aircraft carriers. The RCN could only afford the one carrier, and its replacement, HMCS BONAVENTURE, was due to be commissioned in 1957. Since there was little chance of obtaining a second carrier and there was a need to improve the ASW capability of the surface escorts, the idea of integrating ASW helicopters into the fleet merged, naturally, with the helicopter/destroyer concept. Some, however, urged caution, and Fraser-Harris warned that the concept should not hinder the development of the helicopter as a self-sufficient ASW platform.[17]

The RCN experimented with helicopters landing on a makeshift platform on small warships in September 1956 and November 1957.[18] From these initial experiments, several problems emerged: first, a more robust, all-weather helicopter was required that could operate day and night; second, the ship needed facilities to protect the helicopter from the elements and allow routine maintenance to be performed; and third, a method was needed to safely land and secure the aircraft on the deck in rough seas since small ships experience a greater level of pitch and roll in heavy seas than larger ones. Only if these criteria were met could a helicopter be operated safely for a greater percentage of the time in the unforgiving climate of the North Atlantic.[19]

By now, the Naval Staff began to see the ASW helicopter as having considerable potential, and NATO was urging Canada to accelerate their plans to develop this capability. The acquisition of suitable helicopters was thus given top priority.[20] Unfortunately, there were few helicopters at the time that could carry both weapons and the necessary equipment for the detection and localization of a contact and still operate from small warships in the range of 2,200-tons [1,995.8 tonnes] displacement, such as those in the RCN. The Americans and British had been experimenting with helicopters at sea since the end of the Second World War and had ASW helicopters—such as the piston-engine Sikorsky HO4S-3 (S-55) "Horse" and the British version, the Westland Whirlwind—operating from aircraft carriers by the mid-1950s, but these aircraft had limited capabilities and did not have the proper instrumentation for night operations. The RCN operated a few of these helicopters in the experimental ASW squadron, Helicopter Anti-Submarine Squadron 50[21] (HS 50), and later deployed them on board both MAGNIFICENT and BONAVENTURE in a limited capacity. Sikorsky eventually developed a better version designated the HSS-1N (S-58) "Seabat," which incorporated automatic stabilization equipment and was suitable for both day and night operations. This variant included the latest technology such as the automatic "hover coupler," which used the aircraft's radar to enable the helicopter to come to a pre-selected spot over the water and hover at 50 feet [15.2 m]; this was an important development because it allowed the helicopter to "dip" sonar in both restricted visibility and at night when the pilot's visual reference to the sea was obscured. The British version went into service with the Royal Navy (RN) as the Westland Wessex. Both the USN and RN used these helicopters extensively, and the British were developing the Wessex for operations from large destroyers in the range of the 5,200-tons [4,717.4-tonnes] displacement.[22] The problem with these helicopters was that they were based on an aircraft designed in the 1940s and were, therefore, considered obsolete.

The RCN surveyed other designs such as the Sud-Aviation Djinn, Aérospatiale Alouette, Bristol 203 and the Saunders Roe P-531 (later Westland Wasp). The latter was being developed specifically for use on board destroyers, but it could not carry both a weapon and the necessary detection equipment; therefore, it had to rely on the ship's sensors to locate a target. The Navy also considered the Piasecki/Vertol H-21, the Kaman HOK-1 and HU2K-1 as well as the Sikorsky S-62 as alternatives. In the end, only the Sikorsky, Kaman and Westland Wessex aircraft were recommended.[23]

The Kaman Aircraft Corporation was in the process of adapting its HU2K-1 Seasprite for use on board ships, but it was a single-engine, light-utility helicopter, and neither Kaman nor the USN intended to develop it as an ASW platform at this time.[24] Like the Wasp, the Seasprite was not sufficiently large or powerful enough to carry both weapons and detection equipment. Sikorsky, on the other hand, offered several good options because they were designing helicopters specifically for antisubmarine warfare. The Naval Staff liked the design of the new S-60 series because they had a boat-shaped hull for emergency landings on water, but they were very large helicopters. The S-62 was the smallest version of this series and was a single-engine, civilian-aviation model that went into service with the United States Coast Guard (USCG) as the HH-52A Sea Guard. Although this variant seemed promising, it too would have to be adapted for military use.

The choice was narrowed down to the Seasprite, if it could be developed to carry both weapons and sensors, and another Sikorsky helicopter: the S-63. Both were powered by new turbo shaft engine technology that had just been introduced by General Electric for helicopter use. Compared to these two, all the other helicopters were considered to be either less capable or obsolete.[25] The S-63 was based on the prototype HSS-2 Sea King ASW helicopter with rotor control and transmission components of the HSS-1N (S-58) as well as three powerful engines.[26] Several senior officers favoured this design because the S-58 was already in use with the Royal Canadian Air Force (RCAF) and, therefore, parts could be standardized between the two services. They also preferred a Sikorsky helicopter because the RCN was already operating Sikorsky helicopters and the company was set up with Pratt & Whitney Canada in Montreal.[27] The S-63, however, had encountered development problems that increased the projected cost of the programme and was considered "too large and heavy for operations from escorts."[28]

The smaller Seasprite, with its single 1,100 horsepower [820.3 kilowatt] T58-GE engine, had reached the limits of its performance potential, whereas the Sea King had two 1,175 horsepower [876.2 kilowatt] T58-GE-6 engines and was the first all-weather, day/night ASW helicopter purpose-built for the hunter/killer role. However, each Sikorsky would cost over $100,000 more per aircraft than the cheaper Kaman option. After careful consideration, the Chiefs of Staff Committee (CoSC) concluded that the Seasprite was the reasonable choice for the Navy, while the Vice Chiefs considered it smaller, cheaper and easier to handle in rough weather.[29] A submission was prepared for the Cabinet Defence Committee with a recommendation that the first 12 of a 40-aircraft-acquisition programme be Kaman helicopters with no commitment as to what the remaining type ought to be.[30] These first 12 were to be a Canadian ASW version (CHSK-1) of the HU2K-1 Seasprite at a cost of $16,321,206.[31]

Although the Seasprite seemed the right choice, there was some doubt as to whether Kaman could develop the helicopter to meet RCN needs. When this was brought to the attention of the Vice Chief of the Naval Staff (VCNS), Rear-Admiral Tisdall, he became concerned:

> If there is any doubt that after spending $16,000,000 to get 12 of these helicopters that they do not meet the staff requirements, the RCN is in an extremely embarrassing position.
>
> What CNS [Chief of the Naval Staff] requires is a clear statement on whether or not the Kaman production model with the present engine T-58-6 will do the job we require. Would the S-58 [HSS-1N] do the job we require or not?[32]

He further added:

> I am sure that you realize that the helicopter question must be settled correctly and now, as the future major programme, i.e., new construction surface vessels and conversion programme of ST. LAURENT, depends entirely on the helicopters.[33]

Tisdall was assured that there was no other choice that could operate from the RCN's destroyers, and the Kaman aircraft was being procured in a smaller number as an interim until more capable helicopters could be developed.[34] Here again, the HSS-1N was dismissed as a possible alternative.

Whatever the choice of aircraft, the helicopter needed aviation facilities built into the destroyers to shelter it from the elements and allow for routine servicing and maintenance; this meant a flight deck and hangar had to be retrofitted into existing ships for which they were not designed. The RCN investigated whether all of the frigates and destroyers in the fleet could be adapted to carry helicopters as well as a combination of the new SQS 503 and variable depth (SQS 504) long-range sonar to maximize their ASW capabilities.[35] Moreover, all of the destroyers of the ST.LAURENT, RESTIGOUCHE and repeat RESTIGOUCHE (MACKENZIE and ANNAPOLIS) classes could be altered for about the same cost as one destroyer, making the conversion programme seem quite affordable.[36] Helicopters were, thus, included into the destroyer ASW improvement programme, which was a package deal including as many upgrades as could be achieved.

By June 1960, Treasury Board had approved in principle the aviation facilities for the two latest ships commencing construction, HMCS NIPIGON and HMCS ANNAPOLIS as well as the ST. LAURENT-class conversion programme.[37] Understanding the difficulty the Navy was having in finding a suitable helicopter, Treasury Board did not support the request for 12 Seasprites and, instead, wanted the department to wait until an appropriate helicopter was developed.[38] The Minister of National Defence, George Pearkes, stressed the urgency of having a decision so that the aircraft could be ready by the time the destroyers came back into service after conversion.[39] Treasury Board acquiesced and endorsed the purchase of the Seasprite, which could be accommodated in the redesigned destroyers.[40] With a decision made on the helicopter as well as the ship alterations, it now appeared as if the Navy finally had its ship-borne ASW helicopter programme underway.

However, as was anticipated by some, there were serious problems in converting the Seasprite into a feasible ASW platform, able to carry both weapons and detection equipment. The overall weight and subsequent increase in conversion costs caused grave concern about the aircraft's development potential, forcing the RCN to rethink its plan. The new cost was quoted as being over $23 million, which was an increase in cost per unit to more than that of the larger, more capable Sea King.[41] Moreover, the Sea King had become a proven design and drew serious attention at a lower cost than previously reported.[42] Between the increased cost of the Seasprite and the new Sea King dependability and affordability, an argument for obtaining the latter seemed persuasive.

Yet, the Sea King was designed for carrier operations and, as mentioned, was considered too large for destroyers. In order to accommodate the helicopter in its production form, the ships would need extensive modifications that were previously considered unacceptable. The Sea King was a monster of an aircraft, being a full 10 feet [3 metres] longer and 5 feet [1.5 metres] wider than the Seasprite, even with the rotor blades and tail pylon folded. Its sheer size could not be housed in the destroyer hangars as laid out in the conversion plans. In addition to this, a way had to be found to mechanically manage the big helicopter on the small landing platform and move it into the hanger, since it could not be done manually.

The problem was that the planned aviation facilities were already as large as the engineering branch thought practical and were just enough to accommodate the Seasprite. The space aft of the flight deck was limited by the Mark 10 Limbo mortar's arcs of fire, and there was no room to expand the hangar forward because of the location of the main propulsion and machinery exhaust funnel. The solution was to split the funnel into two, which would allow the hangar to expand forward while venting exhaust on either side of the forward part of the new structure.[43] This modification, however, would cause residual deficiencies that would have to be accepted. First, there was no provision for any widening of the hangar, and second, the extra 30 tons [27 tonnes] of weight would have a negative impact on ship stability.[44] Accepting this, staff planners thought that the helicopter facilities should be increased to accommodate a larger aircraft "regardless of the decision as to what type of helicopter would be embarked."[45] The urgency of the matter was critical because detailed plans of the changes would have to be communicated to the shipyards before the work commenced.[46]

The Naval Board agreed that "the HSS-2 had such advantages for the RCN ASW role that it is worthy of a detailed examination including a cost analysis."[47] However, they remained unconvinced of a programme change. The extent of structural alterations to the destroyers in order to accommodate a larger aircraft was undesirable at this point, so they directed that the hangars were to remain unaltered.[48] Discussions with the Kaman Aircraft Company continued until April 1961 when a Seasprite crashed during a demonstration flight at the Naval Air Training Center (NATC) in Patuxent River, Maryland. The naval member, Canadian Joint Staff (Washington), sent preliminary findings of the accident to naval headquarters and forecasted at least a two-month slippage in the programme.[49] After this, Naval Staff abandoned the Seasprite altogether and recommended that contractual negotiations with Kaman be delayed until after the United States (US) Navy's phase III evaluations.[50]

If the RCN were to acquire the larger Sea King, a decision to enlarge the hangar in the destroyer escorts was required. Further investigation by the Navy's technical services branch revealed that increasing the size of both the landing platform and the hanger could be done without seriously jeopardizing stability because the existing ballast tanks were sufficient to compensate for the added top weight.[51] With this, the Naval Board agreed to an increase in the aviation facilities "to enable an HSS2 helicopter to be operated and maintained."[52] The Chief of the Naval Staff, Vice-Admiral H. T. Rayner, informed the Chairman, CoSC, now Air Marshal Frank Miller, of the new developments.[53] It was explained that, aside from the destroyers, HS 50 needed a replacement for its HO4S-3 helicopters to continue operations from the carrier. An interim acquisition of 10 Sikorsky HSS-2 ASW helicopters was now seen as offering superior value than any other choice.

The sudden change left Miller puzzled. As the former deputy minister, he was well aware of the Navy's fight to acquire helicopters, and he was also surprised by the experimental ASW helicopter unit, HS 50, being referred to as an operational squadron. Before answering Rayner's request, Miller dispatched the committee's secretary, Lieutenant-Colonel D. W. Blyth, to meet with the Director of Naval Aircraft Requirements (DNAR), Captain V. J. Wilgress, to get more answers.[54] Not only was the question of HS 50's status an issue, but it had occurred to Miller that the RCN had shifted its focus by placing priority for acquiring effective ASW helicopters on rearming HS 50 and the carrier instead of the helicopter/destroyer programme. Wilgress confirmed that the Navy was attempting to form an operational ASW helicopter squadron that could operate from the carrier; this is what HS 50 had been doing with the Sikorsky HO4S-3 in BONAVENTURE and is what the Sea King was specifically designed for. The helicopter requirement for the destroyer escorts was described as a second and separate issue and one that had not yet been resolved. Wilgress confessed to Blyth that the Kaman helicopter may still prove to be the most suitable for the destroyer role. The idea of obtaining two different helicopters now became a problem.[55]

By characterizing HS 50 as a shore-based squadron to supply the carrier, the RCN could keep the unit safe from RCAF control because, at the time, the two services were fighting over control of maritime aviation. The CoSC had already made the decision that the RCN could only control aircraft operating from ships; therefore, if HS 50 were considered an operational carrier squadron, then the unit would have a legitimate sea-going role, even if it were stationed ashore at the naval air station at SHEARWATER.[56] Miller explicitly pointed out that "while the Chiefs of Staff had approved a small naval helicopter unit for test and development purposes, there appeared to be no formal approval on record authorizing an operational anti-submarine helicopter squadron."[57] The goal of developing a new ASW weapons system for the Navy's surface escorts had clearly evolved.

While this debate was going on, the Navy's Sea King evaluation team determined that the operational, financial and technical implications of the HSS-2 were well within the RCN's capabilities and resources; furthermore, the aircraft fully met the requirements, including the ability to operate from an escort vessel. There were, however, some additional conditions that needed to be met.[58] First, the rotor blades and tail section would overhang the flight deck; therefore, an automatic system for folding them was necessary. Second, the increased weight of the Sea King would place an additional load on any securing and moving device, requiring a stabilization system for the ship to limit the amount of movement experienced in heavy sea states.[59] Provided these additional criteria were met, the Sea King was a viable option.

With this, the Navy presented recommendations to acquire 10 HSS-2 helicopters for HS 50, but Treasury Board rejected the plan.[60] They believed that since the Kaman procurement had experienced complications and caused much consternation, the Sikorsky one might as well. Treasury Board demanded further trials and a demonstration that the Sea King could, in fact, be operated from the destroyers.[61] The demonstration took place in the spring of 1962 at the Sikorsky manufacturing plant in Stratford, Connecticut. An American Sea King was used along with a makeshift haul-down winch system. Representatives present included those from the Treasury Board, Department of National Defence, USN and the USCG.[62]

The demonstration was a success and the initial procurement was reduced to eight helicopters with the possibility of a follow-on programme for a total of 44 in order to equip HS 50 for operations from the carrier and to outfit the destroyers. A potential order this large now invited the prospect of Canadian production and industrial benefits. With this to consider, the Minister of Finance, George C. Nowlan, brought up the possibility to the Minister of National Defence, Douglas Harkness (who had succeeded Pearkes after the last federal election). The programme now had political appeal, and Harkness agreed. On 26 September 1962, the procurement proposal was put before the Treasury Board who agreed with the purchase of three HSS-2 Sea King helicopters direct from Sikorsky with the follow-on production of five helicopters in Canada.[63]

After this decision, the Minister of Finance referred to the programme as potentially being "a significant accomplishment for Canadian industry."[64] As numerous authors who have written on military procurement have proven, military procurement programmes are often used to stimulate Canadian industry, particularly in times of recession.[65] Canada had entered a recession in 1957, and the early 1960s became a period of both increasing austerity and high inflation. The option of a potentially large programme involving domestic production became quite lucrative to a struggling government facing an economic slump and high unemployment rates. Eventually, 41 aircraft were procured, all of which—except the first four—were assembled at the United Aircraft Company's plant in Longueuil, Quebec, near Montreal. These helicopters were originally categorized as Canadian variants of the HSS-2 and designated CHSS-2, but they would later be redesignated as CH124 Sea Kings to align with the Air Force classification system.

By May 1963, HS 50 began preparing to accept the first Sea Kings; however, helicopter/destroyer trials by VX 10 had to wait until the first ship, HMCS ASSINIBOINE, completed her conversion and transferred to the East Coast later in the fall. One of the big questions that still remained was whether all the necessary maintenance tasks could be performed on board, up to and including a full engine change. The intent was to allow for enough work space "to supply those services required for scheduled maintenance at the squadron level."[66] The problem was that the maintenance capability of a ship at sea was limited by hangar space and ship's motion. Unfortunately, the narrow hangar originally designed for the conversions was based on the smaller Seasprite, and whereas the length of the hangar had been increased with the splitting of the funnel, the width had not.[67] After the initial fit into ASSINIBOINE's hangar in November 1963, it became obvious that the space had to be widened by 5 feet [1.5 metres] to allow for proper equipment stowage and movement around the aircraft. This was eventually done, and by the time the first ship was ready to embark a helicopter detachment for an operational tour, all major maintenance could be performed on board.[68]

The next problem was to devise a method of safely landing and securing the aircraft in rough conditions. The RCN, in partnership with the local aviation industry, developed the idea of a winch-down system that could also traverse the helicopter along an axis from the platform into the hangar. This was accomplished through another Canadian innovation known as the Helicopter Hauldown and Rapid Securing Device (HHRSD) or "Beartrap." Other navies were developing similar systems at the time, but none took the concept as far as the RCN because none were trying to do what the Canadians were doing with the Sea King. Initially, the helicopter was supposed to be introduced into the fleet by 1965. Indeed, a squadron of six Sea Kings embarked in BONAVENTURE for the first time for the annual RCN/USN SPRINGBOARD exercises near Puerto Rico.[69] Delays in the development and acceptance of the Beartrap, however, prolonged the first operational detachment deploying in a destroyer until two years later in May 1967.[70] The problem with the system was the haul-down control, which caused the cable to snap repeatedly under heavy strain. Up until this point, the trials team from VX 10 was using a dockyard fix of the device to progress evaluations. A solution was eventually found, and a new version of the prototype was successful.

The next phase of integrating the helicopter into the fleet required the deployment of a helicopter air detachment (HELAIRDET) on a destroyer for an operational tour. In the summer of 1965, HS 50 was finally designated as an operational ASW helicopter squadron. By the fall of 1966, eight of the nine helicopter destroyers (DDH) were recommissioned into the fleet and were either ready to commence or were already conducting readiness trials or "work-ups." ANNAPOLIS, under the command of Commander D. Mainguy, completed final trials and achieved stage one helicopter capability status in September 1966.[71] Since the ship was scheduled for an upcoming maintenance and training cycle, her sister ship, NIPIGON, was selected to take over trials.[72] The Beartrap was installed and certified in NIPIGON by the end of 1966, and a HELAIRDET from HS 50 was formed for NIPIGON.[73] Since BONAVENTURE had gone into her extended midlife refit in Montreal and NIPIGON was still conducting trials with VX 10, there were no ships cleared for helicopter operations available during the annual SPRINGBOARD exercises in the Caribbean. Instead, the squadron operated ashore from the US Naval Air Station at San Juan, Puerto Rico.

By March, NIPIGON completed helicopter trials and received a Clearance for Service Use (CSU) for stage one flight operations using visual flight rules (VFR); this allowed for daytime and limited night flights in good visibility.[74] The following month, ANNAPOLIS completed her combat readiness inspection and received her daytime clearance.[75] At this point, an HS 50 detachment had still not deployed to a destroyer for an operational tour. A common belief is that HMCS ANNAPOLIS was the first to have a successful deployment (with Sea King 4030).[76] Whereas it is true that the detachment, led by Lieutenant-Commander J. Véronneau, joined ANNAPOLIS on 26 May 1967;[77] this was neither the first operational HELAIRDET formed by HS 50 nor was it the first to embark in a helicopter destroyer. It seems reasonable to assume, then, that NIPIGON was the first. Indeed, according to the RCN Pink Lists (operations schedules), she was listed for the task, and HS 50 appropriately formed its first HELAIRDET in January 1967 for precisely this purpose. But for some reason, the date was pushed back and NIPIGON would not have an operational HELAIRDET embark until later that summer.

The first DDH warship to have an HS 50 HELAIRDET for an operational deployment was actually HMCS SAGUENAY in early May.[78] ANNAPOLIS had received the redesigned control system for the HHRSD in September 1966, but it had been transferred to NIPIGON when the latter ship took over trials. As a result, ANNAPOLIS would not receive a CSU for the new redesigned Beartrap until April 1967. According to the annual report for HS 50, SAGUENAY's HELAIRDET was the first fully operational detachment and the first from HS 50 to use the Beartrap system.[79] By the time Véronneau's detachment joined ANNAPOLIS, SAGUENAY had already been cleared for helicopter operations and was seconded to the NATO Exercise MATCHMAKER squadron with her HS 50 HELAIRDET on board.[80] On top of this, the ship reached the NATO squadron berthed in Newport, Rhode Island, only to receive orders to depart for an emergency situation. The ship was ordered to rendezvous with the Navy's new operational support ship, HMCS PROVIDER, in the eastern Atlantic due to a growing crisis in the Middle East.

At the time, PROVIDER possessed the RCN's second largest sea-going aircraft facilities and did not require a Beartrap for mechanical assistance to operate Sea Kings; in fact, when fully loaded, the support ship boasted a larger displacement than the carrier, making her a very stable platform for helicopter operations. Since BONAVENTURE was in refit, PROVIDER and SAGUENAY were the only ships able to take the Sea Kings on the mission. SAGUENAY with her Sea King, together with PROVIDER carrying three, were to stand ready in anticipation of recovering the Canadian peacekeeping contingent from the Gaza Strip prior to the eventual outbreak of what would become known as the Arab–Israeli Six Day War.[81]

So if NIPIGON and ANNAPOLIS were cleared for helicopter operations around the same time as SAGUENAY, the question remains: what happened to these two ships? There is no clear answer for NIPIGON since her annual historical report (AHR) that covers the period could not be located. According to her ship's logs, however, she spent much of the first three months of 1967 in harbour routine at Her Majesty's Canadian (HMC) Dockyard in Halifax, periodically progressing trials with VX 10.[82] From this, it can be assumed that the ship either entered a maintenance and coursing phase of the ship's cycle or VX 10 was still conducting trials. She eventually set sail for Bermuda in April for a paint ship routine and did not return until the end of the month.

As for ANNAPOLIS, the answer is that she struck a log and damaged one of her brand new 5-bladed noise-reduction propellers during a visit to Bathurst, New Brunswick.[83] When the Middle East crisis erupted, ANNAPOLIS was out of water in the graving dock in Halifax affecting repairs, meaning SAGUENAY was the only fully operational DDH able to deploy with PROVIDER.[84] With the conflict heating up sharply, RCAF Transport Command was eventually called in to remove the contingent while the ships were still 125 miles [201.2 kilometres] west of Gibraltar.[85] SAGUENAY and PROVIDER stood down, reversed course and headed back to Halifax. The ships arrived in harbour the same day ANNAPOLIS was floated and fuelled, with Véronneau's HELAIRDET on board. According to official records, ANNAPOLIS went to flying stations for the first time with an HS 50 detachment on board the same day SAGUENAY arrived back in Halifax after her ordeal with PROVIDER on the other side of the Atlantic.[86]

Having been assigned to the NATO squadron and ordered to a crisis with her Sea King detachment makes SAGUENAY the rightful holder of the distinction of embarking the first HELAIRDET on a DDH for an operational tour. The detachment in ANNAPOLIS, however, was responsible for producing the first manual of standard operating procedures for helicopter operations from DDH ships. For this reason, the ANNAPOLIS HELAIRDET also deserves distinction.[87]

Phase one of the evaluations into the extent to which a CHSS-2 Sea King could be supported in a DDH destroyer was completed by 1968, but the concept of helicopter/destroyer ASW operations would not evolve to include multiple ships and aircraft until later in 1969.[88] In addition to this, full certifications would not be granted for all weather, day/night operations until a reference system was developed to assist the pilot in overcoming disorientation when landing at night and in restricted visibility.[89] This did not happen until the horizon bar was perfected and trialed on board ASSINIBOINE in 1970.[90] Only at this point can it be said that the RCN finally achieved its goal of an all-weather, day/night ASW helicopter capability on board its destroyers.

As mentioned at the beginning, at least one author states that the integration of an antisubmarine helicopter into a destroyer was a radical development and was the envy of other navies while another ventures as far as stating that it "dramatically changed naval warfare."[91] Whereas this may be true from the perspective of a small navy such as the RCN, it is not from allied ASW perspective as a whole. Originally, the helicopter/destroyer concept came about because of the obsolescence of the escort destroyer when dealing with modern submarines. In this case, the aircraft is seen as an extension of the ship's capabilities. Realistically, single ASW helicopters operating from destroyers are limited in what they can do in convoy protection, barrier or search and destroy scenarios when faced with a determined enemy submarine. Major exercises and operations such as the Submarine Launched Assault Missile Exercise (SLAMEX) series as well as surveillance operations during the Cuban Missile Crises in 1962 indicated that proper surveillance and the prosecution of contacts in an open ocean environment such as the northwest

Atlantic is a daunting task—even if the adversary is a conventionally powered submarine.[92] Effective ASW requires an integrated effort involving every available weapon and sensor from fixed sound surveillance systems, surface ships, aircraft and submarines. This is why in 1956, the Naval Warfare Study Group also recommended the integration of the local RCN and maritime air headquarters of the RCAF into a single command on each coast. Only in this way could the RCN better incorporate the medium- and long-range patrol capabilities of the P2V-7 (CP-127) Neptune and CL-28 (CP-107) Argus maritime patrol aircraft into the overall ASW effort within each Canadian area of responsibility.[93]

The USN and RN focused much of their efforts on ASW carrier groups and large hunter-killer submarine forces. The American navy figured out early in the cold war that the best platform to hunt and destroy an enemy submarine is actually another submarine; this is why they concentrated so much effort on the development of their all-nuclear attack submarine (SSN) force. During the 1950s, some within the RCN aggressively campaigned for acquiring SSNs and for retaining MAGNIFICENT as a specialized ASW helicopter carrier for exactly this reason, but financially, neither option could be supported. The helicopter/destroyer concept, therefore, did not dramatically change naval warfare; it simply added another valuable tool to an already existing tool box.

Simply put, the RCN carried on with what it could. HS 50 operated its HO4S-3 helicopters from MAGNIFICENT as an ASW squadron in 1956 and would do so with frequency later in BONAVENTURE after "Maggie" was paid off. By early 1965, the squadron embarked the first Sea Kings in "Bonnie" for major exercises in the Caribbean. Eventually, they established that out of a carrier squadron of six Sea Kings, two could be maintained concurrently in the air 24 hours a day for a period up to 10 days in what is referred to as sustained operations (SUSTOPS).[94] The reason this is so important is because exercises throughout the period established that a minimum of two aircraft were required to maintain contact because of the aircraft's short endurance "on station." In comparison, the destroyer's air detachment could maintain a single Sea King on sustained operations for a period in excess of 12 hours.[95]

Whereas a carrier squadron could rotate aircraft to and from a contact area, a destroyer could not because the helicopter would have to return to the ship periodically to refuel. This and the transit time are referred to as "dead time" during which the target submarine is afforded the chance to escape.[96] For this reason, a carrier squadron was actually more effective in ASW than one helicopter deployed from a destroyer. Unfortunately, by the time the first Canadian destroyer deployed with her full all-weather, day/night ASW potential, the carrier HMCS BONAVENTURE was decommissioned. From this point forward, the RCN had no choice but to operate their Sea Kings solely from its destroyers.

In conclusion, developments in submarine and missile technology during the 1950s were some of the more significant for maritime warfare during the cold war. Because of this, the RCN was forced to adapt or face obsolescence with respect to its surface ships and its central role of antisubmarine warfare. The age of the surface escort was at an end unless a system could be found that could range out and not only detect but also destroy an enemy submarine; this became the role of the ship-borne ASW helicopter, which led to innovation and success within the RCN. Unfortunately, only the seven ST. LAURENT class and two ANNAPOLIS class were ever converted to carry the Sea King as the 1960s proved to be turbulent years, financially and organizationally, for the Canadian Armed Forces. Of the seven RESTIGOUCHE class destroyers, four would later be fitted with the antisubmarine rocket (ASROC) torpedo system while the MACKENZIE class remained without any ASW upgrades and were eventually reassigned to the training squadron on the West Coast.

Interestingly, the British were quite successful in adapting their HSS-1N variant, the Westland Wessex, into a fully capable gas-turbine ASW helicopter, able to operate from their large *County*-class guided-missile destroyers. The helicopters went into service with the Fleet Air Arm in 1961, while the first *County*-class destroyer, Her Majesty's Ship *Devonshire*, was commissioned in November 1962, ahead of the converted ST. LAURENT class. If the RCN had selected the Wessex for its ship-borne helicopter programme, the modifications to its ships would have been less extensive because the dimensions of the Wessex (with rotor blades and tail pylon folded) were similar to that of the Seasprite for which the original aviation facilities were designed. The Sea King, however, outperformed the Wessex considerably in all categories.

In the end, the RCN successfully adapted some of its ships for heavy ASW helicopter operations and pioneered this new capability, thereby making a significant contribution to the allied ASW effort during an important period of the cold war. After the unification of the three armed services in 1968, what was left of this part of Canada's naval aviation legacy became the responsibility of the air element, who continued to operate the venerable Sea King from frigates and destroyers at sea for the next four and a half decades. With this, the Navy's ship-borne helicopter capability was firmly and competently secured by Canada's professional Air Force, which will no doubt continue to do so with future maritime helicopters.

Notes

1. Commander Tony German, *The Sea Is at Our Gates: The History of the Canadian Navy* (Toronto: McClelland & Stewart Inc, 1990), 9, 244.

2. J. D. F. Kealy and E. C. Russell, *A History of Canadian Naval Aviation* (Ottawa: Queen's Printer, 1967); James A. Boutilier, ed., *RCN in Retrospect, 1910–1968* (Vancouver: University of British Columbia Press, 1982); W. A. B. Douglas, ed., *RCN in Transition, 1910–1985* (Vancouver: University of British Columbia Press, 1988); Michael Hadley, Rob Huebert, and Fred W. Crickard, ed., *A Nation's Navy: In Quest of Canadian Naval Identity* (Montréal–Kingston: McGill-Queen's University Press, 1996); and Richard H. Gimblett and Richard O. Mayne, ed., *People, Policy and Programmes: Proceedings of the 7th Maritime (MARCOM) Historical Conference (2005)*, (Trenton: Canadian Naval Heritage Press, 2008).

3. See Isabel Campbell, "A Brave New World, 1945–60" in *The Naval Service of Canada: The Centennial Story*, ed. Richard Gimblett (Toronto: Dundurn, 2009); Richard Mayne, "Years of Crisis: The Canadian Navy in the 1960s" in *The Naval Service* (see this note); Peter Haydon, "From Uncertainty to Maturity, 1968–89," in *The Naval Service* (see this note); and Marc Milner, *Canada's Navy: The First Century* (Toronto: University of Toronto Press, 1999).

4. Peter Charlton and Michael Whitby, ed., *"Certified Serviceable" Swordfish to Sea King: The Technical Story of Canadian Naval Aviation by Those Who Made It So* (Ottawa: CNATH Book Project, 1995); Peter Charlton, *Nobody Told Us It Couldn't Be Done: The* VX 10 *Story*, 2nd ed. (Ottawa: privately printed, 1995); Stewart E. Soward, *Hands to Flying Stations: A Recollective History of Canadian Naval Aviation*, vol. 1, *1945–1954* (Victoria, BC: Neptune Developments, 1995); Stewart E. Soward, *Hands to Flying Stations: A Recollective History of Canadian Naval Aviation*, vol. 2, *1955–1969* (Victoria, BC: Neptune Developments, 1995); Aaron Plamondon, *The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter* (Vancouver: UBC Press, 2009); and Michael Shawn Cafferky, *Uncharted Waters: A History of the Canadian Helicopter-Carrying Destroyer* (Halifax: Centre for Foreign Policy Studies, 2005).

5. This paper is based on larger research conducted for volume III of the official history of the RCN, 1945–1968. The author is indebted to Michael Whitby, senior naval historian, and Isabel Campbell for sharing their views and offering comments on early drafts. Any views, errors or omissions remain the responsibility of the author.

6. See Chapter 7 of Norman Friedman's, *U.S. Submarines Since 1945: An Illustrated Design History* (Naval Institute Press: Annapolis, 1994).

7. *Canadian Naval Intelligence Bulletin* (*CNIB*), vol. III, no. 8, January 1956, 3–4.

8. *CNIB*, Vol. IV, no. 4, July–August 1956, 2–3.

9. See Michael Whitby, "Fouled Deck: The Pursuit of an Augmented Aircraft Carrier Capability, Part 2, 1956–64," *Canadian Air Force Journal* 3, no. 4 (Fall 2010): 6–20.

10. Memo from VCNS to CNS and others, 23 October 1956, attached to Naval Board (NB), 508–9, 24 October 1956, DHH, 81/520/1000-100/2, box 25, file 1.

11. Isabel Campbell, "A Transformation in Thinking: The RCN's Naval Warfare Study Group of 1956," in *People, Policy and Programmes* (see note 2), 166; and Campbell, "A Brave New World," 134, 136.

12. As quoted in Michael Whitby, "Views from a Different Side of the Jetty: Commodore A. B. F. Fraser-Harris and the Royal Canadian Navy, 1946–1964," *The Northern Mariner* 22, no. 1 (January/ February 2012): 12.

13. Mayne, 146.

14. Naval Staff (NS), 504-6, 12–26 December 1950, DHH, 81/520/1000-100/3, box 33, file 3; NS, 557-1, 7–20 May 1953, DHH, 81/520/1000-100/3, box 34, file 1; and Whitby, "Views from a Different Side," 13.

15. *CNIB*, Vol. III, no. 5, October 1955, 37–40, DHH, 91/128.

16. Memo from VCNS to CNS and others, 23 October 1956, attached to NB, 508–9, 24 October 1956, DHH, 81/520/1000-100/2, box 25, file 1.

17. Campbell, "A Transformation in Thinking," 178; and Whitby, "Views from a Different Side," 13.

18. In HMCS BUCKINGHAM during September 1956 and in HMCS OTTAWA during November 1957.

19. Results of these trials were reported in COMOPVAL Project Staff/SE 18, dated 1 February 1957, Library and Archives Canada (LAC), Record Group (RG) 24, 1983-84/167, box 3827, file 8260-11, pt. 2.

20. Memo from Director of Under Sea Warfare (DUSW) to Assistant Chief of the Naval Staff (Air & Warfare) ACNS(A&W), dated 4 February 1959, DHH, 79/246, box 10, file 81; Memo from CNS to Chairman, Chiefs of Staff (CCoS) with draft submission to the Cabinet Defence Committee, dated 10 April 1959, DHH, 79/246, box 10, file 81; and Appendix "A" to minutes of 4/59 meeting of NS, 24 April 1959, DHH, 81/520/1000-100/3, box 35, file 1.

21. In 1952 the RCN adopted the USN naval air squadron designations. See Kealy and Russell, 56. Therefore, squadron names were written with the squadron number following the description. HS 50 appears in Canadian Forces Organization Order 9.5.2 (18 March 1968) as Helicopter Anti-Submarine Squadron 50. In mid-1968, the naval air squadron designations were changed to place the number before the description. HS 50 thus appears in Canadian Forces Organization Order 9.5.2 (24 June 1968) as 50 Helicopter Anti-Submarine Squadron.

22. Although the S-58 was originally designed with a piston engine, Wessex adapted it with a gas turbine engine to become the world's first to be manufactured in large quantity. They went into service on board British aircraft carriers and *County*-class destroyers in 1961–1962. Owen Thetford, *British Naval Aircraft since 1912* (London: Putnam & Company, 1958), 354.

23. "Brief on ASW Helicopters in the RCN," no date, DHH, 86/377.

24. The Seasprite would eventually be adapted for ASW but not until the Light Airborne Multi-Purpose System (LAMPS) programme in the 1970s.

25. Memo from VCNS to CNS, dated 18 September 1959, DHH, 79/246, box 10, file 81.

26. *Jane's All the World's Aircraft, 1959/60* (Toronto: McGraw-Hill, 1960), 382–83.

27. Vice Chiefs of Staff Committee (VCoSC), 48 item I, 12 December 1958, DHH 73/1223, series 3, box 62, folder 1308; and Memo from VCNS to CNS, dated 11 December 1958, DHH, 79/246, box 10, file 81.

28. Memo to DUSW from Assistant/Chief of Naval Technical Services (Air) A/CNTS(Air), dated 5 January 1959, DHH, 79/246, box 10, file 81; and Memo to ACNS(A&W) from DUSW, 6 August 1959, DHH, 79/247, box 10, file 81.

29. CoSC, 628 item IV, 29 January 1959, DHH, 73/1223, box 63; and memo from Sec. VCoSC to Sec. CoSC, dated 18 September 1959, DHH, 79/246, box 10, file 81.

30. "Helicopter Summary," DHH 86/377; and CSC 648, 5 November 1959, DHH, 73/1223, box 63, file 1310A.

31. Draft memo to Cabinet Defence Committee (CDC), December 1959, DHH, 79/247, box 10, file 81.

32. Memo from VCNS to ACNS(A&W), dated 17 December 1959, DHH, 79/246, box 10, file 81.

33. Ibid.

34. Memo from ACNS(A&W) to VCNS/CNS, dated 18 December 1959, DHH, 79/246, box 10, file 81.

35. NS 11/58-2, 24 June 1958, DHH, 81/520/1000-100/3, box 35, file 1.

36. NB 584-4, 16 January 1959, DHH, 81/520/1000-100/2, box 25, file 4.

37. Treasury Board (TB) 566257, 16 June 1960, attached to letter from TB to Deputy Minister of National Defence (D/MND), 23 June 1960, DHH, 79/246, box 10, file 81; and "Helicopter Summary." The TB approved the Improved ST. LAURENT programme on 23 June 1960. NB, special meeting, 22 July 1960, DHH, 81/520/1000-100/2, box 25, file 5.

38. "Helicopter Summary"; and letter from TB to D/MND, 5 October 1960, DHH, 79/246, box 10, file 81.

39. Memo from Minister of National Defence (MND) to TB, September 1960, DHH, 79/246, box 10, file 81; and letter from MND to TB, no date, LAC, RG 24, acc. 1983-84/167, box 3427, file 7820-102, vol. 3.

40. The sketch design of the ANNAPOLIS class given to the VCNS, Rear-Admiral Tisdall, in 1959, clearly shows the hangar with a silhouette of a Kaman Seasprite inside the hangar and aft of the main funnel. DHH, 79/246, box 2, folder 6.

41. NB, 643-1, 27 January 1961, DHH, 81/520/1000-100/2, box 26, file 1.

42. Cafferky, 288; and Naval Staff Paper, "ASW Helicopter Procurement," dated 18 January 1961, DHH, 79/246, box 10, file 81.

43. The Naval constructor branch was asked to conduct a design study to find a solution to accommodate the HSS-2, and it was presented as an appendix in a Naval Staff paper. In his published memoirs, then ACNS(A&W), Commodore J. V. Brock, claims he came up with the idea during a meeting with the Naval Staff. Shawn Cafferky, however, attributes the solution to the Naval Constructer-in-Chief, Commodore Freeborn, with introducing this solution. Jeffry V. Brock, *With Many Voices: Memoirs of a Sailor*, vol. II, *The Thunder and the Sunshine* (Toronto: McClelland and Stewart, 1983), 82; and Cafferky, 310.

44. NB, 643-1, 27 January 1961, DHH, 81/520/1000-100/2, box 26, file 1; and Appendix "C" to 7820-102 (Staff) "ASW Helicopter Procurement," 18 January 1961, 79/246, box 10, file 81.

45. Minutes of a Meeting Held in Director of Naval Ship Requirements (DNSR) on Wednesday, 18 January 1961, DHH, 79/246, box 10, file 81.

46. Ibid.

47. NB, 643-1, 27 January 1961, DHH, 81/520/1000-100/2, box 26, file 1.

48. Ibid.

49. Naval Message DTG (date-time group) 181726Z Apr 62, LAC, RG 24, acc. 1983-84/167, box 3344, file 7801-102-5, pt. 3.

50. Memo from ACNS(A&W) to VCNS, dated 8 August 1961, DHH, 79/246, box 10, file 82; Naval Policy Co-ordinating Committee (NPCC), 217-3, 9 August 1961, DHH, 79/246, Box 2, folder 4; and NPCC, 218-4, 15 August 1961, DHH, 79/246, folder 4.

51. NPCC, 218-4, 15 August 1961, DHH, 79/246, folder 4; and NB, 657-1, 23 August 1961, DHH, 81/520/1000-100/2, box 26, file 1.

52. NB, 657-1, 23 August 1961, DHH, 81/520/1000-100/2, box 26, file 1.

53. Letter from CNS to CCoS, dated 23 October 1961, LAC, RG 24, acc. 1983-84/167, file 7820-102, vol. 3.

54. The details of Blyth's visit and the questions that the chairman wanted answered are outlined in a memo from DNAR to VCNS, dated 27 October 1961, LAC, RG 24, acc. 1983-84/167, box 3427, file 7820-102, vol. 3.

55. Ibid.

56. Letter to Sec, CoSC, from DNAR, dated 26 October 1961, LAC, RG 24, acc. 1983-84/167, box 3427, file 7820-102, vol. 3.

57. The squadron would not be officially designated as an operational squadron until July 1965, after it had deployed aboard the carrier for major exercises in the Caribbean during Ex SPRING BOARD '65. CoSC 704, item III, 9 November 1961, LAC, RG 24, acc. 1983-84/167, box 3427, file 7820-102, vol. 3.

58. Both reports are located in NPCC project file B-2. DHH, 79/246, box 10, file 82.

59. "The Suitability of the HSS-2 as an Alternate Choice of Helicopter for ASW Operations from Destroyer Escorts," 27 October 1961, DHH, 79/246, box 10, file 82.

60. Memo to MND from D/MND, dated 27 December 1961, DHH, 79/246, box 10, file 82.

61. Letter from Sec TB to D/MND, 16 January 62 (TB 590367) and reply memo from D/MND to CNS, 17 January 1962, NPCC project file B-2. DHH, 79/246, box 10, file 82.

62. Cafferky, 293–95.

63. Minutes of meeting to discuss the equipment requirements in the initial procurement of HSS-2 helicopters, on 17 September 1962, LAC, RG 24, acc. 1983-84/167, box 3428, file 7820-102-6, vol. 1; and letter from the Minister of Finance to the Minister of National Defence, dated 9 October 1962, LAC, RG 24, acc. 1983-84/167, box 3428, file 7820-102-6, vol. 1.

64. Letter from the Minister of Finance to the Minister of National Defence, dated 9 October 1962, LAC, RG 24, acc. 1983-84/167, box 3428, file 7820-102-6, vol. 1.

65. See D. W. Middlemiss and J. J. Sokolsky, *Canadian Defence: Decisions and Determinants* (Toronto: Harcourt Brace Jovanovich, 1989); and Michael Hennessy, "The Rise and Fall of a Canadian Maritime Policy, 1939–1965: A Study of Industry, Navalism and the State" (PhD diss., University of New Brunswick, 1995).

66. Lieutenant A. M. Percy, "Aircraft Facilities in DDE Conversions," n.d. DHH, 93/110, box 5, item 061.

67. Ibid.

68. Charlton and Whitby, 117.

69. Report of Proceedings for January 1965, HS 50, LAC, RG 24, 1983-84/167, box 721, file 1926-219/50. Canadian preparations and participation in this annual exercise were called MAPLE SPRING.

70. See Chapter 15 of Charlton.

71. AHR for 1966–67, HMCS ANNAPOLIS, 13 March 1968, DHH, 1277; message from CANMARCOM, DTG 280306Z June 1966, DHH, 81/520/8000, box 71, file 2; and Message from VX 10 to CANFORCEHED, DTG 262032Z January 1967, DHH, 81/520/8000, box 71, file 2.

72. Message from CANMARCOM, DTG 280306Z June 1966, DHH, 81/520/8000, box 71, file 2.

73. According to *Certified Serviceable*, NIPIGON's system had received its CSU in November 1966, yet VX 10 did not begin acceptance trials of NIPIGON's HHRSD until 6 December 1966 according to the VX 10 report by Lieutenant Commander Heath. DHH, 2000/15, box 6, file 102104. It is probable that the November 1966 CSU was for a dockyard retrofit of the system, and the "production" version was not installed and certified until the later date.

74. "Draft Project Management Charter for Completion of Aviation Facilities in DDH 205 and 265 Classes," n.d., DHH, 2010/1, file 11900 DDH-01, vol. 2. The full certification for day and night all-weather operations—Stage 2 CSU for instrument flight rules (IFR)—had to wait for a number of other factors including the fitting of a suitable stabilized horizon reference, upgraded communications, flight deck lighting, tactical air navigation (TACAN) and suitable approach radar. Minutes of Meeting on DDH 205 and 265 Class Ships Aviation Facilities, 12 November 1970, DHH, 2010/1, file 11900 DDH-01, vol. 2. See also memo and notes from the Technical Coordinator DDH Aviation Facilities to Director General Maritime Systems (DGMS), 30 January 1968, DHH, 2010/1, file 11900 DDH-01, vol. 2.

75. AHR for 1966–67, HMCS ANNAPOLIS, 13 March 1968, DHH, 1277.

76. Jean Véronneau, "The First Helicopter Air Detachment (Annapolis) from 4 April to 28 November 1967," *Warrior* (Spring 2010). Stuart E. Soward also makes this claim in, *Hands to Flying Stations*, vol. 2, 394–95; and Marc Milner accepts Soward's claim in *Canada's Navy*, 259.

77. Ship's Log for May 1967, HMCS ANNAPOLIS, 26 May 1967, LAC, RG 24, vol. 5488.

78. See George Huson, "A History of the Helicopter Hauldown and Rapid-Securing Device," *Maritime Engineering Journal* (September 1985); and Commander R. A. Douglas, "Helicopter/Ship Interface: Canadian Experience of Helicopter Hauldown and Rapid Securing Device" (paper, Commonwealth Engineer Officers' Conference, Bath, 15–16 September 1977), 213–20, DHH, 93/110, item 082.

79. AHR 1967, HS 50 (423 Sqn), DHH, 1312.

80. Ibid. MATCHMAKER was the code name for the multinational NATO ASW squadron that would eventually become known as the Standing Naval Force, Atlantic or STANAVFORLANT. SAGUENAY's HELAIRDET is correctly identified as the first operational one in both AHR 1967, HMCS SAGUENAY, DHH, 1293 and Patrick Martin and Leo Pettipas, *Royal Canadian Navy Aircraft Finish and Markings, 1944–1968* (Martin Slides, 2007), 145, 246.

81. AHR 1967, HS 50 (423 Sqn), DHH, 1312; and AHR 1967, HMCS SAGUENAY, DHH, 1293.

82. Ship's Logs for January–April 1967, HMCS NIPIGON, LAC, RG 24, vol. 5470.

83. Wilf Lund, interview with Vice-Admiral Dan Mainguy, 18 April 2001, DHH, 2001/30, file 1.11, (Protected B); and Ship's Log, HMCS ANNAPOLIS, 15 May 1967, LAC, RG 24, vol. 5488.

84. AHR 1967, HS 50 (423 Sqn), DHH, 1312; AHR 1967, HMCS SAGUENAY, DHH, 1293; and Ship's Log for May 1967, HMCS ANNAPOLIS, LAC, RG 24, vol. 5488.

85. AHR 1967, HS 50 (423 Sqn), DHH, 1312.

86. Ship's Log for May 1967, HMCS ANNAPOLIS, LAC, RG 24, vol. 5488; and Ship's Log for May 1967, HMCS SAGUENAY, LAC, RG 24, series D-12, vol. 5481.

87. Véronneau, 63; and the "Guide to DDH/Helicopter Operating Procedures," January 1968, which can be found at DHH, 2000/15, box 8, file 105396.

88. This was first done during the annual Canada–US MAPLE SPRING exercises off Puerto Rico in 1969. Memo from DGMS to Director General, Engineering DG ENG, 21 January 1969, DHH, 2010/1, file 11900 DDH-01, vol. 2. The complete report of Phase I of VX 10 Project Directive 132 is unclassified and held by Defence Research Development Canada (DRDC).

89. Without a visual reference to the horizon, the only thing the pilot could see in reduced visibility or at night was the moving ship beneath him. The resulting disorientation caused vertigo, which many pilots encountered because of the ship's motion relative to the aircraft. Put simply, what the pilot's body was feeling in terms of his balance and motion did not relate to what his eyes were seeing in terms of the pitching and rolling of the deck and hangar beneath him; therefore, his sense of balance was thrown off and this led to severe discomfort. Former test pilot Lieutenant-Colonel Glenn Cook (Retired) to author.

90. The author would like to acknowledge the material and experiences offered by former pilots, Glenn Cook and Bob Murray, who related information over many conversations on Tuesdays at the Canada Aviation and Space Museum in Ottawa where they work diligently at piecing together Canada's military aviation legacy.

91. Plamondon, 72.

92. See Peter T. Haydon, *The Cuban Missile Crisis: Canadian Involvement Reconsidered* (Toronto: Canadian Institute of Strategic Studies, 1993); and Mayne, 154.

93. Memo from VCNS to CNS and others, 23 October 1956, attached to NB, 508-9, 24 October 1956, DHH, 81/520/1000-100/2, box 25, file 1.

94. Report of Proceedings for March 1965, HMCS BONAVENTURE, DHH, 81/520/8000, box 11, folder 2.

95. Report on Helicopter Operations in HMCS ANNAPOLIS, January–August 1966, LAC, acc. 94-0831, box 36, file 11900 DDH 265-01.

96. Mayne, 146.

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Chapter 4

Ship-Helicopter Interface Flight Testing

Wally Istchenko

Introduction

Canada procured the Sea King (CHSS-2 and later designated as the CH124) helicopter in the early 1960s, taking first delivery in 1963, and began the integration with the destroyer escorts (DDEs) of the ST. LAURENT class (205/265) shortly thereafter. This new concept required extensive development and testing to combine these two capabilities. Personnel from the Royal Canadian Navy's Experimental Squadron 10[1] (VX 10) had to carry out extensive ship-helicopter interface and compatibility testing to establish the new procedures and the limitations to be used by the operational crews. In subsequent years, modifications to the helicopter-capable ships, the introduction of new classes of ships and modifications to the Sea King created the need for more testing, leading to the introduction of new technology and new techniques.

Even though initial feasibility trials had been done on Her Majesty's Canadian Ship (HMCS) BUCKINGHAM and later on HMCS OTTAWA utilizing the HO4S and S-58 helicopters, the integration of the Sea King and a DDE was new territory. VX 10 was heavily tasked with testing a variety of helicopter and shipboard systems. Project Directive 102 focused on establishing the feasibility of the CHSS-2/DDE (once a helicopter was placed on board, the ships were redesignated as destroyer helicopter carrying [DDHs]) concept. Initial efforts focused on the development of the Winch Down and Handling System (later referred to as the Helicopter Hauldown and Rapid Securing Device [HHRSD] or "Beartrap"). The HHRSD was a vital piece of the technology that made the concept viable, but Canadians were not the first to consider this approach to helicopter-ship integration.

During World War II, Anton Flettner—a German engineer and head of Anton Flettner, *Flugzeugbau GmbH* which specialized in helicopters—developed the FL 282 Kolibri ("Hummingbird")—a single-seat, open-cockpit, intermeshing-rotor helicopter. The German Navy was impressed with the FL 282 and wanted to evaluate it for submarine spotting duties. Flight testing of the first two prototypes was carried out through 1941, including repeated take-offs and landings from a pad mounted on the German cruiser *Köln*. A rope and winch was used during these landings, a rudimentary "human powered" attempt at implementing a "hauldown system" many years before the development of HHRSD in Canada. After the war, Anton Flettner moved to the United States and eventually became chief designer for Kaman Helicopters.

Early feasibility trials showed that landing the helicopter was not the only concern, rapidly securing and manoeuvering the helicopter after the landing in higher sea states was a major issue. The traversing capability of the rapid securing device eliminated the need for traditional deck handling. The hauldown concept was tested by VX 10 in 1960 using a nylon rope attached to the cargo-hook sling at the release point of the HO4S-3 helicopter. A team of seven men hauled on the rope to pull the helicopter down without upsetting the stability of the aircraft, confirming the feasibility of the concept. At the same time, the United States Navy was testing a constant tension winch to land a drone helicopter on the United States Ship *Hazelwood*, a technique adopted by Canada in the development of the HHRSD.[2] Success did not come easily, but a dedicated effort over several years by naval engineers and civilian personnel with support from industry was needed to fully develop the sophisticated capability which became known as the Beartrap. This was an essential element needed to launch the era of Canadian maritime helicopter operations on small ships.

This paper will not focus on the development of the HHRSD,[3] but it is clear that turning this concept into reality was a significant achievement. In this paper, I will review the methodology used by VX 10 and Aerospace Engineering Test Establishment (AETE) personnel over the years to see what changes were made and the impact these changes had on the procedures and limitations established for day-to-day operations. I will describe the flight test techniques used to establish the operational limits, starting with the work done by VX 10 on the DDH 205/265 (1963–68), and then will review the approach used by AETE when conducting the Flight Acceptance Trials of DDH 280 Class Helicopter Hauldown and Rapid Securing Device and Ship Compatibility with CH124 Helicopter (1973–74); Strake Trials on DDH 205/265, TRIBAL class DDH 280s as well as oiler replenishment (AOR) ships 508, 509 and 510 (1988); Recovery Assist, Secure and Traverse (RAST) Mark (MK) III trials on HMCS OTTAWA (1992); and Canadian patrol frigate (CPF) trials (1992–93). The review is based on information available in the project reports created by VX 10 (disbanded in 1970 and absorbed into AETE) and AETE itself. These reports were made available courtesy of the Canadian Forces (CF) and AETE.

DDH 205/265

Crew from VX 10 started day flying and deck handling trials from Shearwater and on board HMCS ASSINIBOINE in October 1963. The trials were divided into seven stages in order to manage the gradual build-up approach to possible danger areas and system specification limits. All aspects of the operation were evaluated, and initial operating procedures and criteria were established. The circuit and approach procedures utilized today are still very close to those established by VX 10. Landings were made during the steady period directly from the high hover, and the judgment of the landing safety officer (LSO) played a vital role during the landing. A total of 347 day deck landings were conducted during this phase (both freedeck [untethered] and hauldown [tethered]), and a preliminary safe-flight envelope for shipboard operations was established. It was concluded that the hauldown system was both desirable and essential for the operation of the CHSS-2 from DDE ships but that work was required to address numerous hauldown and other shipboard system deficiencies. Additional HHRSD and CHSS-2/DDH compatibility trials were conducted in 1966, and final heavy-weather day and night trials were conducted on HMCS ANNAPOLIS in December 1967 and January 1968. During the heavy-weather trials, a further 112 deck landings were conducted in ship-motion conditions close to the limits of the HHRSD (9 degrees [°] pitch and 31° roll). The tail guide winches used to straighten the aircraft after landing were introduced as part of these trials.[4]

Pilots from VX 10 utilized qualitative assessments of difficulty, control margins and the precision of the landings to establish procedures and operational limitations. They concluded that the precision of the landings was affected by ship motion, relative wind speed and direction, functioning of the automatic stabilization equipment (ASE), functioning of the auxiliary servo as well as pilot familiarity and skill. It was clear that use of the hauldown cable (tethered) significantly improved the precision of the landings. Lulls in pitch and roll were predictable and of sufficient duration to permit take-off and landings during the steady period. During daylight tests, pilots were able to detect the commencement of a large pitch or roll, but this was much more difficult at night. Freedeck landings were attempted under all conditions, but landing accuracy diminished at the extremes of the wind and ship-motion envelope during daylight, and accuracy at night was not good enough to ensure a safe landing. Freedeck landings at night were considered to be a flight emergency and were only to be attempted if there was no alternative.

The VX 10 trials recommended operational launch and recovery envelopes up to ship-motion limits of 31° roll and 9° pitch for daylight operations. The tail guide winches performed satisfactorily and were required for straightening operations in higher sea states, but further night trials were required to define the safe night-time operating limits.

TRIBAL Class – DDH 280

The CF (this was post-unification) launched four TRIBAL class (DDH 280) destroyers in the early 70s. These “sisters of the space age” were designed for long-range antisubmarine warfare with a significant part of the ship designed to support two Sea King helicopters. Project Directive 71/2-1 tasked AETE to carry out acceptance tests of the DDH 280 HHRSD to assess the general suitability of the ships for helicopter operations and to qualitatively evaluate the new horizon reference system. The basic procedures had been developed by VX 10 on the DDH 205/265 class, so the AETE team focused on the differences. The significant items were the two traps, a swinging bellmouth which allowed the hauldown system to work for either trap, a new LSO console which allowed the LSO to select and operate either trap, a modified horizon reference system on the hangar top and improved night lighting for the landing deck.

The trials were divided into three phases. Phases I and II (functional, static and preliminary flight trials) were conducted on each of the four new ships (HMCS IROQUOIS, HMCS ATHABASKAN, HMCS ALGONQUIN and HMCS HURON). Phase III (rough weather trials) were only conducted on one ship (HMCS ATHABASKAN). Rough weather trials on one representative ship were considered acceptable since all ships had been functionally checked. The horizon reference system was evaluated during Phase III.

System functional checks and static trials of the HHRSD were conducted alongside while preliminary flight trials were started at a buoy in Halifax harbour and later completed at sea. HMCS HURON was tested first (requiring 15.1 flight hours) and was followed by HMCS IROQUOIS (requiring 19.2 flying hours). A total of 70 destroyer deck landings (DDLs) were conducted on HURON with up to 5° roll and 2° pitch; while on IROQUOIS, 168 DDLs were performed with ship motion up to 15° roll and 3° pitch. Preliminary flight trials on the first two ships indicated that the test programme could be abbreviated without adversely affecting the tests. Accordingly, only 18 DDLs were conducted on ATHABASKAN with ship motion up to 15° roll and 3° pitch, and 18 DDLs were conducted on ALGONQUIN with maximum ship motion of 5° roll and 1° pitch.

Phase III rough-weather trials utilized a build-up technique of gradually working up to the maximum sea conditions for safe helicopter operations. A total of 26.9 hours were flown and 206 DDLs (152 day, 54 night) were performed with maximum ship motion of 20° roll and 5° pitch. Test instrumentation installed by AETE allowed the team to measure and record a number of parameters, including cable tension, cable velocity, ship's pitch and roll as well as horizon-bar pitch-and-roll error. The complete Sea King / DDH operation was investigated under conditions of up to 20° roll and 5° pitch and winds up to 55 knots (100 kilometres per hour [km/h]).

Landing techniques were fundamentally the same as those employed on the DDH 205/265 class ships. To make best use of the new horizon bars in higher sea states, it was recommended that the aircraft line up on the ship's centreline in the high hover, thus making a lateral move to the appropriate trap location (port or starboard) necessary when transitioning to the low hover. Freedeck landings were found to be overly difficult and hazardous in conditions exceeding 10° roll and 3° pitch. Due to the weather conditions encountered during the trials, deck motions beyond 20° roll and 5° pitch were not encountered, but the test team concluded that the HHRSD demonstrated it was fully capable in all modes to the limits encountered (20° roll and 5° pitch). The horizon bars proved to be an excellent reference; although, the pitch bar only demonstrated minimal value. The LSO pitch and roll indicators were very helpful in assessing a ship's steady periods. The conclusions were based on a combination of quantitative data and qualitative assessments made by the test team. If operational requirements dictated a need to assess deck handling of the Sea King with ship motion in excess of these encountered during the test, further trials would be required. The recommendations for operational limits are provided in Table 1.

Landing Type	Conditions	Roll (°)	Pitch (°)
Hauldown	day/visual flight rules	15	5
Hauldown	night / instrument flight rules	10	5
Freedeck	day / visual flight rules	10	5

Table 1. Recommended operational limitations for Sea King DDLs[5]

Tail-Boom Strake

The implementation of the Sea King Tail Boom Strake trial in 1987 was the next time a need arose for ship-helicopter interface flight testing. The strake, a piece of angled aluminum mounted on the left side of the tail boom, was designed to interrupt the airflow over the tail boom.

Testing had demonstrated increased tail rotor control margins at some azimuths, resulting in the pilot requiring less left pedal when flying at low speed. The objective of the ship-helicopter interface flight testing was to remove the restriction in the launch and recovery relative-wind envelope (Green wind[6] greater than 15°) for all-up weights in excess of 18,000 pounds (8,165 kilograms). A secondary objective was to demonstrate the capability of the Sea King helicopter to operate safely over the deck within the redefined envelope with a true tailwind component.

Testing was conducted on all three classes of helicopter-capable ships. The AORs were not equipped with the HHRSD, so only freedeck landings were possible, but both freedeck and hauldown landings were conducted on the DDHs. Helicopter in-flight refuelling (HIFR) was evaluated on all of the ships. Test points also included automatic stabilization equipment and auxiliary-servo "Off" assessments to the low hover only. In order to manage risk, a build-up technique was used, working from the cleared relative-wind envelope in increments of 15° or 5–10 knots (9.3–18.5 km/h).

The test team utilized the Cooper-Harper Handling Qualities Rating Scale (Figure 1) and the United States Naval Air Test Center Pilot Rating Scale (Table 2) to quantify their assessment of pilot workload. These scales were developed to help standardize the subjective assessments of the test pilots.

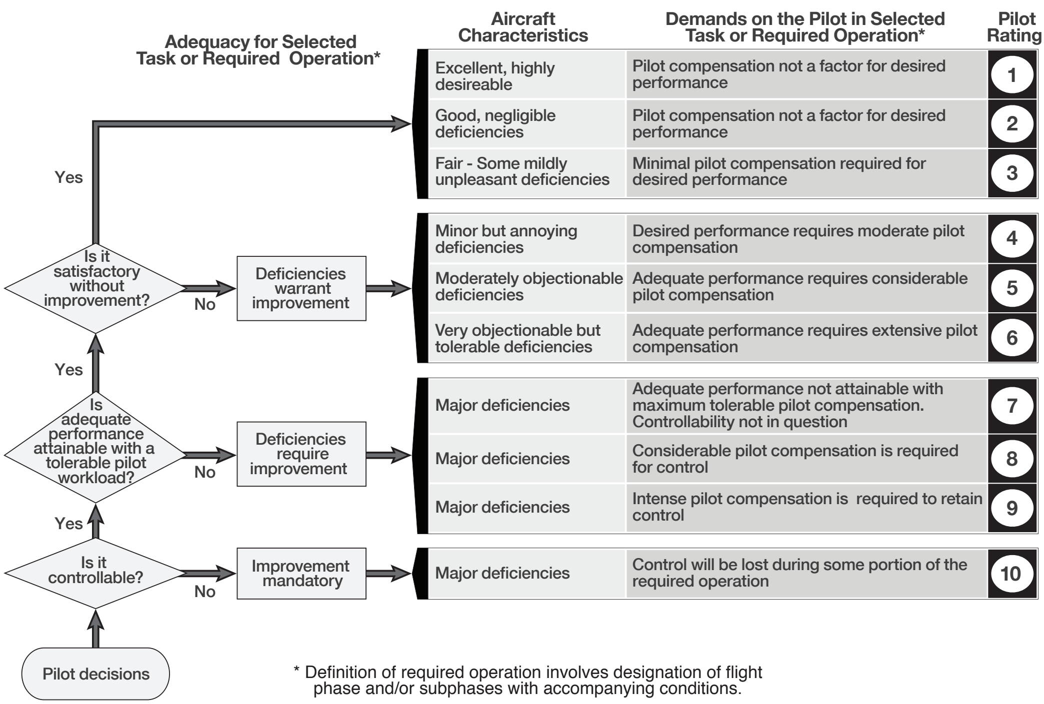


Figure 1. Cooper-Harper Handling Qualities Rating Scale[7]

Pilot Rating Scale No.	Pilot Effort	Description
1	Slight	No problems, minimal pilot effort required.
2	Moderate	Consistently safe launch and recovery operations under these conditions. These points define the fleet limits recommended by NAVAIRTESTCEN [Naval Air Test Center].
3	Maximum	Landing and takeoffs successfully conducted through maximum effort of experienced test pilots under controlled conditions. These evolutions could not be consistently repeated by fleet pilots under operational conditions. Loss of aircraft or ship system is likely to raise pilot effort beyond capabilities of average fleet pilot.
4	Unsatisfactory	Pilot effort and/or controllability reach critical levels, and repeated safe landings and takeoffs by experienced test pilots are not probable, even under controlled test conditions.

Table 2. United States Naval Air Test Center Pilot Rating Scale [8]

The tail-boom strake modification increased tail rotor pitch margins for launch as well as freedeck and hauldown recovery at maximum gross weights under all relative-wind conditions. HIFR operations in Green relative winds at more than 15° for AORs and 30° for DDHs increased the pilot's workload to unacceptable levels due to turbulence from the hangar as well as the power required. Ship motion was the most significant contributor to pilot workload, and collective activity was high for all manoeuvres over the flight deck. In order to reduce the risk of a dual engine over-torque (103 per cent), it was recommended that a minimum power margin of 15 per cent (delta between power available and power required to hover out of ground effect) be utilized for shipboard landings, HIFR and vertical replenishments (VERTREP) and 5 per cent for take-offs. All calculations should be based on mean indicated relative wind speed.

Landings with true tailwind components of up to 21 knots (39 km/h) were demonstrated. Closure rates on approach were higher than normal, so it was recommended that Doppler ground speed be monitored to adjust closure rates. Power required to hover over the deck was high due to the low relative wind, so it was recommended that a power margin of 15 per cent between power available and power required to hover out of ground effect in zero wind be utilized.

Although it was not an objective of the trial, test data from the night heavy-weather landings confirmed that ship motion and night operations significantly impact pilot workload. These same conclusions were reached during the initial VX 10 trial and the testing carried out on the TRIBAL class destroyers.[9]

RAST MK III

In 1992, after more than 20 years of operational experience with the HHRSD, AETE was tasked to ascertain whether the new Recovery Assist, Secure and Traverse MK III developed by Indal Technologies could be employed safely and if it had potential for recovering a Sea King helicopter on a Canadian DDH. The RAST MK III concept was a major redesign of the original HHRSD. The system had a wider open-mouth trap (securing device) with a larger designated landing area (DLA), and there was no hauldown cable. A claw-like mechanism would capture/grab the main probe after landing.[10]

Two ship-mounted cameras were used to track eight infrared sources on the helicopter; this data was used by a six-degrees-of-freedom software program to determine the location of the main probe over the DLA. Using this information, the traverse winch positioned the trap 18 inches [45.7 centimetres] aft of the helicopter main-probe position. The position of the probe with respect to the DLA was displayed to the pilot by means of a pilot visual cuing device. The position of the

DLA was corrected for ship's motion, thus presenting a stable reference for the hover and landing. After the aircraft landed in the DLA, the trap was fired (trap advanced from the position aft of the DLA so the claw could capture the probe). The aircraft was then secured on deck. The system was designed to include a ship-motion prediction capability, but it was not ready to be evaluated.

Testing was conducted in three phases, starting alongside in Halifax, then at a buoy in Bedford Basin and then at sea. A total of 43 hours were flown in light to moderate sea states (3° pitch and 6° roll). Procedures were adapted from the *Shipborne Helicopter Operating Procedures* (*SHOP*) manual. Landing performance was assessed using quantitative data from shipboard (e.g., landing accuracy and ship motion) and aircraft (e.g., control margins and torque) instrumentation. Pilot workload was assessed using the Cooper-Harper Handling Qualities Rating Scale, introduced during the Strake Trials. Weather conditions did not generate the sea states needed to reach system-design limits, but numerous technical issues were identified which needed to be corrected before the system would be ready for service use. Also, trends in the data indicated that the RAST MK III system limits for deck motion and relative wind would be similar to freedeck limits with the HHRSD, and it would probably not match the wind and ship motion envelope possible using the hauldown cable.[11]

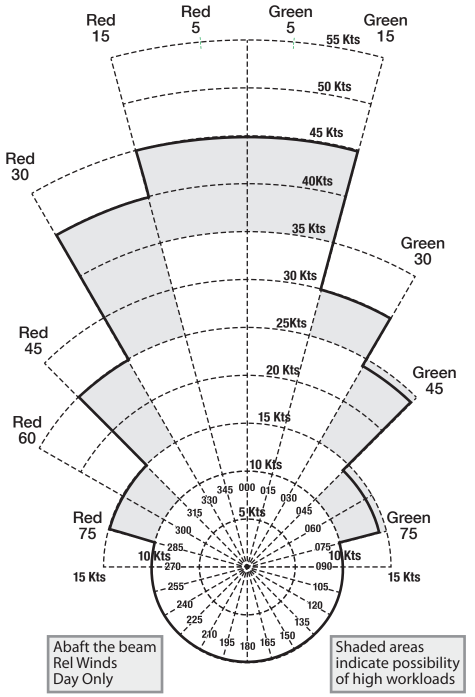
Canadian Patrol Frigate

The introduction of the CPF (or HALIFAX class) in the 1990s created the requirement for another very large-scale flight-test programme. The objective of the ship-helicopter interface flight-test programme was to determine the full ship-operating envelope. Limits were to be determined by the HHRSD (design limits), pilot workload and authorized wind limits. The team also had to conduct electromagnetic interference / electromagnetic compatibility (EMI/EMC) testing to determine the impact of CPF systems on the Sea King.

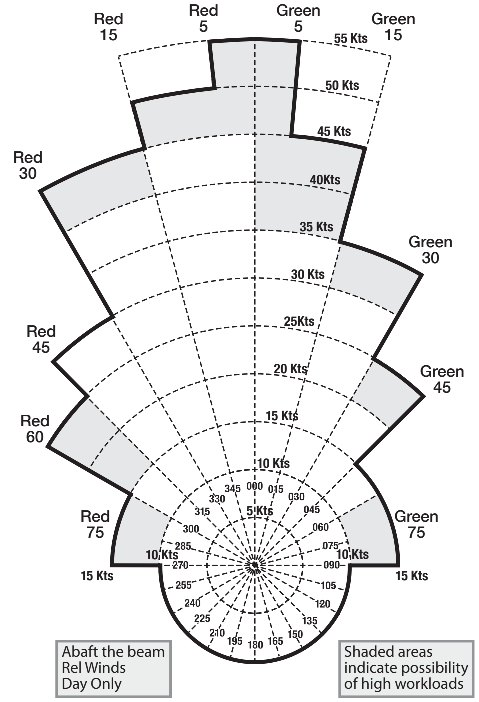
EMI/EMC testing and basic functional checks of all shipboard systems were completed prior to commencing flight testing. Wind-tunnel testing and a wind-over-deck survey were conducted to calibrate the ship's anemometers with respect to the actual wind conditions over the deck and to get a better understanding of the characteristics of the airflow over the deck. The wind-over-deck survey data indicated that the wind-tunnel data was not representative of conditions over the deck. The main reason for this difference was the model used for wind-tunnel testing was not representative of the final design in a number of key areas. The wind-over-deck survey data was analysed and then used during the flight-test planning process to reduce the number of test points by about 10 per cent. The analysis also highlighted the value of the survey, the need to ensure the full anticipated envelope be covered and that additional temperature and wind data be obtained on future surveys.

Flight testing utilized a build-up technique, starting with calm conditions, daytime and a 20-knot (37-km/h) wind on the nose. Standard operating procedures remained virtually unchanged from those established for the DDH 205/265 and the TRIBAL class. Relative wind, sea states and helicopter weight were increased to establish limits based on aircraft performance or pilot workload. On-board instrumentation allowed the flight-test team to monitor key aircraft parameters (e.g., control margins, torque and engine parameters) during each flight while the Cooper-Harper Handling Qualities Rating Scale and the Pilot Rating Scale (improved since the Strake Trial) were used for each test point. A Vibration Rating Scale and a Sea Spray Accumulation Rating system were also utilized to standardize the reporting methodology of these issues.

The CPF is a relatively stable platform in pitch and roll, but flight deck vertical acceleration (FDVA) in higher sea states became a limiting factor. FDVA is a combination of heave, vertical acceleration at the ship's centre of gravity and ship's pitch. In sea state 7 conditions, maximum pitch and roll encountered were 6° and 24°, well within the limits of the HHRSD, but FDVA was 0.3–0.4 gravities (g)—the vertical velocity between 600 and 1,000 feet per minute (3–5.1 metres per second). The high FDVA could be attributed to the position of the flight deck (46.5 metres aft of midship and 20.5 metres from the stern) relative to the centre of gravity, but it was clear that ship-motion limits needed to be defined by pitch, roll and FDVA. As seen in Figure 2, the recommended ship-motion limits for launch and recovery were less than the HHRSD capability and varied depending on the availability of FDVA data. Turbulence created by the ship's superstructure and other obstructions reduced the maximum wind envelope; thus minimum torque margins for operations over the deck were recommended. An equivalent wind envelope was developed to document the delta between the ship's anemometers and the conditions over the deck.



SITUATION (Day or Night)	MAX PITCH (Deg)	MAX ROLL (Deg)
Straightening and Traversing with RSD	5	20
Land with RSD (Freedeck) Launch/Land without HHRSD Hoist Transfers VERTREP	3	10
Secured on deck with RSD	9	31



SITUATION	MAX PITCH (Deg)	MAX ROLL (Deg)	MAX HEAVE (g)
Straightening and Traversing with RSD	5	20	
Launch with RSD Land with HHRSD (Without vertical rate indicator)	4	25	-
Launch with RSD Land with HHRSD (With vertical rate indicator)	6	25	.30
Secured on deck with RSD	9	31	
Night Land/Launch	4	15	.30

(a) CITY class frigates freedeck wind and ship motion	(b) CITY class frigates hauldown wind and ship motion envelopes

Figure 2. CITY class frigates wind and ship-motion envelopes[12]

Discussion and Conclusion

The objective of this paper was to review the techniques used to carry out Sea King ship-helicopter interface flight testing over the past 50 years and to assess the impact of the variations and the new technologies introduced over that time.

The fundamental principles utilized by VX 10 crews as they developed the initial CHSS-2/DDH concept and the major conclusions they reached have been validated. VX 10 personnel must have borrowed heavily from procedures and techniques used for aircraft-carrier operations as they developed the capability to operate the Sea King on Canadian frigates, but they followed a methodical approach to determine end points and establish operational limits. Test programmes started with functional checks of all of the systems required to support helicopter operations. Flight testing followed a build-up technique, starting from the centre envelope and increasing the relative wind and sea state to establish the operational limits. Conclusions were based on quantitative and qualitative data. Aircraft performance issues (such as limited control margins, torque limits and landing accuracy) were measured during each test point and combined with the subjective assessment of pilot work to establish operational limits. Also, each test programme has validated the conclusions that ship motion is the key contributor to pilot workload and that night operations are more demanding than daytime operations in similar conditions.

Over the years, aircraft and ship-board instrumentation systems improved, providing teams with much better quantitative performance data. The various rating scales (Cooper-Harper Handling Qualities Rating Scale, Pilot Rating Scale, Vibration Rating Scale and Sea Spray Accumulation Rating) were introduced in order to help standardize qualitative assessments (i.e., pilot workload) made by the test crews. Wind-tunnel testing and wind-over-deck surveys provided test teams with data that was used to better plan test programmes, and ship-motion recording and analysis—with the focus on FDVA—allowed the teams to better understand the risk associated with this phenomenon.

It is clear that, over time, there has been a significant increase in the amount and quality of the data available to support the conclusions being drawn by the test teams. Test teams were in a position to better understand flight-test results; furthermore, flight-deck heave/acceleration concerns raised by operational crews have been substantiated with hard data. The technology and new techniques produced a lot more data, but the relative-wind and ship-motion limitations established for Sea King operations have not changed significantly since the concept was first developed by VX 10 in the early 1960s.

The performance of the Sea King has improved over the years (upgraded engines, longer tail rotor blades and tail boom strake), and ship design has created a more stable platform, but the conclusions reached and limits established by the pioneers at VX 10 remain unchallenged. The fundamentals of methodical approach taken by the pioneers who developed the HHRSD and the CHSS-2/DDH concept have stood the test of time and the introduction of new technology. Sea King operations on small Canadian naval vessels remain the benchmark for flying at the edge of the envelope, and the Sea King / DDH concept remains a hallmark of Canadian skill and ingenuity.

Notes

1. VX is a two-letter naval designator that stands for heavier than air (V) and experimental (X, the unit's function).

2. George Huson, "A History of the Helicopter Hauldown and Rapid-Securing Device," *Maritime Engineering Journal* 4, no. 2 (September 1985).

3. See Peter Charlton and Michael Whitby, *"Certified Serviceable": Swordfish to Sea King – The Technical History of Canadian Naval Aviation by Those Who Made It So* (Ottawa, Ontario: CNATH, 1995). Chapter 18 "The Helicopter Carriers" has details on the HHRSD. CNATH stands for Canadian Naval Aviation Technical History.

4. VX10, "Report on Phases V and VI CHSS-2/DDH Hauldown and Handling System Day and Night Flying and Shipborne Handling Trials," 11 March 1968.

5. AETE Report 71/2-1, "Flight Acceptance Trials of the DDH 280 Class Helicopter Hauldown and Rapid Securing Device and Ship Compatibility with CH-124 Helicopter," 26 May 1975.

6. Green winds are from the starboard, and red from the port.

7. AETE Report 87/43, "CH-124 Sea King Tail Boom Strake Relative Wind Envelopes – Shipborne Trials," 23 June 1989.

8. Ibid.

9. Ibid.

10. AETE Report 88/10, "CH-124A Recovery Assist Secure and Traverse MK III Advanced Development Model Flight Testing," 12 March 1993.

11. Ibid.

12. AETE Report 88/26, "CH-124A Canadian Patrol Frigate Flight Deck Qualification," 30 June 1994.

Wally Istchenko

Wally Istchenko graduated from the Royal Military College of Canada with his Mechanical Engineering degree in 1976. He received his Canadian Forces pilot wings in 1977 and, after helicopter conversion training, spent 6 years as an operational CH124 Sea King pilot in Shearwater, Nova Scotia.

In 1984, Wally completed the Engineering Test Pilot course at the United States Naval Test Pilot School in Patuxent River, Maryland. He spent the subsequent 5 years at the Aerospace Engineering Test Establishment in Cold Lake, Alberta, as an active test pilot, carrying out systems and aircraft handling qualities test programmes on various helicopter types. He returned to Cold Lake in 1992 and spent three years as Senior Test Pilot, responsible for the safe and effective completion of complex and high-risk flight test activities on fixed- and rotary-wing Canadian Forces aircraft.

In 1996, Wally was appointed Commanding Officer of 406 Maritime Operational Training Squadron, where he had his last opportunity to fly the CH124 Sea King. During his years in the Canadian Forces, he also spent time in requirements and project management positions at National Defence Headquarters in Ottawa as well as two years at the German General Staff College in Hamburg, Germany, and one year at the Inter-American Defense College in Washington, DC.

Wally retired from the Canadian Forces in 2005, joining General Dynamics Canada, where he worked as a member of the project management team on North Atlantic Treaty Organization programmes.

He was appointed to his present position as Chief Flight Test, National Aircraft Certification Branch at Transport Canada in November 2009, where he manages a team of engineering test pilots and flight test engineers who work with manufacturers to conduct, monitor and review flight tests of Canadian- and foreign-manufactured aircraft for which Canadian-type certification is requested.

Chapter 5

Sea King Passive Acoustics: The Canadian Story

Mark Aruja

This story is about how a handful of dedicated Canadians, without the guidance of an overarching government policy, helped save the Western world. A stretch perhaps, but the story starts during the heart of the cold war. This was a time when the world lived under the threat of mutual assured destruction (MAD), the formal recognition in policy that the Union of Soviet Socialist Republics (USSR) and the United States (US) could annihilate one another and the world with nuclear weapons. The survivability of the opposing nuclear powers was built around a triad concept: air launched nuclear weapons delivered by bombers, land-launched missiles from silos deep in the heartland of the protagonist, and sea-launched missiles from submarines lurking unseen and unheard in the deep water of the world's oceans. This paper will examine the dramatic evolution in our naval capability to challenge the Soviet submarine fleet, the silent member of the Soviet triad of MAD doctrine.

This story is about people; it is about technique and it is about technology. It touches on the most secretive and the most complex warfare specialty that Canada has ever engaged in. Although this account will refrain from explaining the technical and operational complexities of antisubmarine warfare (ASW), hopefully it will provide sufficient information so that everyone can appreciate it. In the course of the narrative, the names of certain key players will be invoked, but due to space limitations, many of the actors—some on centre stage and others in the wings—will be left out.

This story is about passive acoustics, otherwise known as "Jezebel." A project by that name was undertaken at the Bell Laboratories in the early 1960s to explore long-range acoustics. Briefly, Jezebel processes acoustic information by analysing the sounds in the sea according to their frequency components and displaying the information on a continuously moving graph in a frequency-versus-time format. Each type of surface ship and submarine has a unique frequency "fingerprint" that allows the Jezebel operator to identify the type and the nationality of the target.

The only form of energy that travels efficiently in water is acoustic energy. No better example can be provided than the energy created by an undersea earthquake, which results in this energy being dissipated far away on distant shores by a tsunami. Any moving object will put sound into the water, particularly machinery and propellers. This sound energy will then advance through the water with its movement and energy dissipation governed primarily by the interaction of the sound waves with the surface, the interaction with the bottom of the ocean, and the effects of changing sound velocity in the ocean mass itself. The distance that the sound energy will travel is also dependent upon the frequency of the sound and the intensity of the transmission. The lower the frequency, the less the ocean absorbs the sound, and the further it will travel.

Great investments had been made by the USSR and the US to develop technologies and techniques to minimize the energy transmitted by submarines into the water. At the same time, both nations invested heavily in the development of sensors and techniques to exploit the acoustic vulnerabilities of their adversary. The efforts were underpinned by both a massive research programme to collect and analyse hydrographic data from the world's oceans and an equally massive intelligence effort to understand the design of the adversary's submarine and, therefore, what its acoustic signature would look like.

During the Second World War (WWII), active acoustic detection technology and techniques were developed by the British. These were referred to as ASDIC (an abbreviation of Anti-Submarine Detection Investigation Committee; the body that researched this techonology). ASDIC transmitted a pulse of acoustic energy and then detected its reflections. With an appropriate detector that could measure the arrival angle of the returned pulse, it is possible to determine both the direction of a submarine and—by knowing the speed of sound in water, approximately 1 mile [1.6 kilometres (km)] per second—the distance from the transmitter. We know this today as sonar, short for sound navigation and ranging. WWII also gave birth to passive acoustics; that is, listening to the sounds emitted by submarines. This led to the development of sonobuoys, devices which could be launched from aircraft and upon entering the water had a floating mechanism deployed at the surface from which a listening device, or hydrophone, deployed. The detected sounds were transmitted to the aircraft via a radio link to a sonobuoy receiver. By the 1960s, this technology was widely used in Canada on long-range maritime patrol aircraft such as the CP107 Argus (a land-based maritime patrol aircraft [MPA]), and the CP121 Tracker (then launched from Canada's aircraft carrier). However, in 1970, with the decommissioning of Her Majesty's Canadian Ship (HMCS) BONAVENTURE, the only passive acoustic capability in the Navy employed by the Tracker was retired, and here is where the story starts.

The Navy was left with only an active sonar capability. These active sonars were mounted on the hulls of vessels or a variable depth sonar, otherwise known as dipping sonar and invented by Canadian researchers at the Naval Research Establishment, was towed at depth. There was also a variable depth sonar on the CH124 Sea King helicopter. Unfortunately, the 1970s had some dramatic events which rendered this capability ineffective or, to put it more bluntly, useless against the contemporary threat.

Throughout the late-1950s and into the1960s, the Soviet Union had focused heavily on the expansion of its land- and air-based nuclear capabilities. It was not until the ascension of Admiral Sergei Gorshkov that the Soviet navy truly transformed into a lethal force. Gorshkov was already a rear-admiral in 1941 in command of the Azov Flotilla on the Black Sea. He was appointed Commander of the Red Navy in 1956 by Khruschev. However, at the time, the Soviet navy was relegated to the higher priorities of land and air based nuclear capability and the development of the army and air force in general. It was not until after the debacle of the Cuban missile crisis and the subsequent replacement of Khrushchev by Brezhnev in 1964 that Gorshkov was given the broadest latitude to develop a capable navy. It was now recognized that even though the land mass of the Soviet Union was large, it still did not compare to being able to conceal nuclear weapons in the 70 per cent of the world covered by oceans. Gorshkov was particularly concerned with defeating the American aircraft-carrier capability and embarked on a comprehensive plan to develop new nuclear-powered submarines and associated weapons, including the development of the cruise missile. Gorshkov commanded the Soviet navy until 1985, a sign of his political longevity and the length of time over which his vision was implemented.

The first generation of Soviet nuclear submarines started being commissioned in 1955 and were named by the North Atlantic Treaty Organization (NATO) as the *Hotel, Echo*, and *November* classes (ballistic missile, cruise missile carrying and attack submarines, respectively). These were relatively noisy and relatively easy to detect for both the Sound Surveillance System (SOSUS)[1] and maritime-patrol aircraft. They also had relatively short-range weaponry, which limited their capability. However, in the late 1960s, a formidable new generation of submarines were being built to replace them.

The *Yankee* class ballistic missile submarine, the *Charlie* class cruise-missile-equipped submarine, and the *Victor* attack submarine were markedly quieter than their predecessors, and they carried a sophisticated suite of weaponry. The *Yankees*, with multiple re-entry warheads, could now engage the entire European and American continents from patrols in the Atlantic and Pacific oceans. Produced in great quantities, 34 *Yankees* alone were constructed in eight years, which permitted the Soviet Navy to achieve a rough parity with its Western counterparts. More distressingly, John Anthony Walker,[2] the infamous American spy, provided the Soviets with detailed insights into American submarine quietening technology, which they were subsequently able to implement after the sale of specialized milling machinery by Toshiba and Kongsberg to the Soviet Union. As a result, Soviet submarines got even quieter.

The Royal Canadian Navy (RCN), once a proud ASW-capable service, had no answer to this threat, and there is little indication that there was a strategic understanding of the impact of this situation within the Canadian defence establishment. Fortunately, the maritime air patrol world was actively engaged in prosecuting Soviet submarines with effect, and they were backed by an industrial base in Canada, a strong defence research base, and excellent relations with the US and United Kingdom (UK) defence establishments, due in no small measure to operational, scientific, and industrial contributions being made by Canada to counter this lethal threat.

In the 1960s, the limitation of the single-sensor capability provided by the Sea King dipping sonar was already recognized in Ottawa. After a thorough analysis by National Defence Headquarters (NDHQ), Maritime Command Headquarters, and operational research personnel, a suite of sensors and equipment was proposed as the Sea King modernization programme. However, when other flight-safety-related problems, notably with the Doppler and radar altimeter, were merged with this sensor programme, budget constraints prevailed, and the subsequent safety of flight and aircraft refurbishment package trumped the sonobuoy processing and display system, deferring this initiative until monies could be found. Nonetheless, successive staffs within the Directorate of Maritime Aviation (DMA) and their engineering counterparts in the Directorate of Maritime Aviation and Engineering Management (DMAEM) 4 continued to fight for this capability.

The 1970s heralded the coming of age of digital computing and microprocessors. In comparison to ships, submarines, and maritime patrol aircraft (MPA), helicopters could not carry the heavy analog processors and displays, nor could they carry the weight of the necessary load of sonobuoys. Notable amongst myriad technological challenges that were being overcome was the invention of the Fast Fourier Transform algorithm in 1965, which dramatically sped up the capability for signal processors to carry the computational loads required for acoustics.[3] Fortunately, when the impetus rose to create helicopter solutions, and specifically solutions for Canada's Sea Kings, there were several strengths to draw upon. The first was a strong core of ASW practitioners, operators and engineers in the MPA community. The second was a domestic industrial base, and the third was an excellent relationship with the UK and United States Navy (USN) in the most sensitive areas of technology development and advancements in the art and science of ASW. This was due in no small part to the decades of excellence in the Naval Research Laboratory and more broadly in the Chief of Research and Development (CRAD) Branch.

It is important to note that many technologies had to come together to allow a system to be put into the Sea King and to work effectively in the independent operations concept. As submarines were being made quieter, the drive to achieve higher acoustical performance in sonobuoys was needed. In the 1960s, the US began developing the passive Low Frequency Analysis and Recording (LOFAR) sonobuoys. Although a great leap in acoustic quality over the WWII-era radio sonobuoys, these sonobuoys were omni-directional in operation and, at the time, triangulation of the underwater contact location required a large field of buoys and considerable skill on the part of the operator.

In the US, the Sikorsky SH-60 helicopter, also known as the Light Airborne Multi-Purpose System (LAMPS) MkIII aircraft, was taking shape; however, they had fitted their "Proteus" acoustic processor on-board ship, which was connected to the helicopter's sonobuoy receivers via a wideband directional datalink. The merits of this arrangement were widely debated. With the larger helicopter, Canadians were not convinced that the Sea King should only be employed with a dipping sonar in the tactical screen. Emerson, an American company, and Computing Devices Canada (CDC), today known as General Dynamics Canada (GDC), both believed that the development of a sufficiently lightweight acoustic processor that could be installed in a helicopter was viable.

CDC had gained substantial signal-processing expertise working on Project CAESAR, today known as SOSUS. As it became understood through scientific validation, the complexity of detecting and classifying acoustic signals was as much a human performance issue as was signal and display processing. The Automated Processing of Jezebel Information (APOJI) processor was the first airborne processor of its type to try to aid the operator, was developed by CDC, and flew in the Argus.

Whereas APOJI did not go into operational service, it provided a lot of insight for both engineers and operators in the maritime-patrol community on the state of the art in signal processing.

Emerson had developed a very compact and highly advanced processor named "CALYPSO." In 1974, demonstrations impressed the Canadians, resulting in Emerson submitting an unsolicited proposal to NDHQ. In those early days, Bud McLean, Jim Faulkner, and Dave Clarke were part of the staff organization that had become experts on how to move projects through the bureaucracy after successive tours in Maritime Air Group Headquarters (MAGHQ) Senior Staff Officer (SSO) Evaluation and Requirements and DMA. McLean was tasked with drawing up a memorandum of understanding between the Department of National Defence (DND), the USN and Emerson to conduct an operational evaluation of the system. Despite USN objections, Emerson managed to have a CALYPSO installed on a Jacksonville-based USN Sea King (HS1 or HS3). Unfortunately, a failed gearbox terminated the initiative. Subsequently, the CALYPSO showed up on HMCS PROVIDER for an exercise out of San Diego. Sonobuoy receiver antennas were mounted high on the mast, and a USN Reserve Sea King laid sonobuoys while McLean plotted their locations on an Mk6 plotting board. That was as close as the USN got to evaluating the system.

Lieutenant-Colonel (LCol) John Bauer was then responsible for the DMAEM 4 section, dedicated to acoustics within the Materiel Group located at Rockcliffe, Ottawa, and they were pulling for the Emerson opportunity. They also had an excellent relationship with CRAD. Everyone in the decision chain reviewed the draft paperwork at every stage, so that by the time it got to NDHQ from Air Command Headquarters it flowed smoothly through to Rockcliffe, where CRAD funding was secured. Apparently, this was all done at the staff level, with little or no involvement from the senior management in the Air or Naval staffs. Clarke and Major Rob Irving were both key to getting the paperwork reading exactly the way CRAD wanted it. However, the CALYPSO processor was but one of many challenges to be overcome. Since the closure of the RCN's VX-10 Squadron[4] in 1970, there was no organization within the Sea King community that could have undertaken the proposed trials and evaluations. It was no insignificant coincidence that the Helicopter Operational Test and Evaluation Facility (HOTEF) had just been created as a unit in 1979, with Major Boyko the first officer in charge; around 1980 CALYPSO was fitted into the HOTEF aircraft. The CALYPSO processor was only one component of a suite of equipment that had to be acquired, integrated, and installed. For example, the existing ARR52 sonobuoy receivers in the Sea King were inadequate. Fortuitously, a set of suitable ARR75 receivers, which had been demonstrated in Rockcliffe in 1972, were sitting on John Bauer's desk. That solved that problem. Sonobuoy antenna locations on the Sea King were determined as a result of antenna radiation pattern studies done with the National Research Council. The evolution of sonobuoys, equally necessary for their use in helicopters, was also realizing significant results.

The omnidirectional passive sonobuoys were unsuited for helicopter use because the number of buoys that needed to be put in the water and the amount of operator effort required to localize a submarine overwhelmed any helicopter crew. Fortunately, the US had developed means to get directional information from passive sonobuoys, known as Direction Frequency Analysis and Recording (DIFAR), which was being produced by Hermes Electronics in Dartmouth, Nova Scotia. Similarly, the omnidirectional active sonobuoy placed the same burdens on the aircraft and crew. Again, with good timing, the Directional Command Activated Sonobuoy System (DICASS) had been developed. With target-bearing information, the ability of a crew to determine the target's position was dramatically simplified. At the time, there was an excellent relationship with the USN in the Sonobuoy Working Party, a tripartite group (US, UK, and Canada) which was responsible for the development of sonobuoy requirements and the associated technology. The USN lead, Dan Rosso, was instrumental in getting DICASS sonobuoys diverted off the US production line for the CALYPSO trials. Unfortunately, the Sea King did not have a radio transmitter on board that could provide the necessary commands to the DICASS sonobuoys to trigger their acoustic pulses. Bauer was trying to figure out a solution when he was reading about the AN/ARC-552 ultra-high frequency (UHF) radio, which was on the Sea King.

In the technical specification it referred to an "x" mode used for an encrypted channel, which was unused. As it turned out, that mode had the necessary attributes (bandwidth) to do the command function. In addition, the AN/ASN-501 tactical navigation computer was replaced by the Teledyne AN/ASN-123 Tactical Navigation computer, a digital easy-to-use system which had the size and weight which would easily fit into the tactical navigator working area. Moreover, it had the capability to create and manage the much more complex tactical situation that passive acoustics created. Finally, a tape recorder and ancillaries were included in the overall suite. With the removal of the dipping sonar, the CALYPSO system was installed by the Aerospace and Telecommunications Engineering Support Squadron (ATESS) in Trenton, and money was quite generously made available to not only conduct trials but also get support from Emerson to undertake the expected engineering changes. During the testing of the installation, there was some considerable discomfort when the Aerospace Engineering Test Establishment (AETE) announced that in order to clear the envelope they would have to see what happened when DICASS sonobuoys were released simultaneously from all of the six sonobouy chutes. At $5,000 per sonobuoy, this expensive trial became known as the "Cadillac" pattern.

A few additional comments on the broader topic of sonobuoy development would be worthwhile.

The requirement for a directional acoustic sensor for Canada was satisfied by experimental hardware with Project Tandem in the mid-1970s. By this time, the US had developed the DIFAR system, which used a novel scheme that automatically corrected the acoustic data to magnetic north. This DIFAR system was pursued by both the US and Canada since it was considerably simpler than the TANDEM approach with similar performance. The DIFAR sonobuoy was developed for production by 1968, and to date more than three million have been produced worldwide.

The standard sonobuoy size was 36 inches [91.4 centimetres] high; for helicopters, the pursuit of smaller sonobuoys involved considerable challenges in trading off performance against size. After all, there was no net gain if a smaller, lower-performing sonobuoy required that more of them be deployed and carried. The trade-offs involved volume available for the battery, room for the cable pack, suspension, and drogue (the mass that stabilizes the hydrophone at a select depth). Hermes Electronics, today part of the Ultra Electronics group in Dartmouth, was, and remains, a major player in this domain. It is perhaps noteworthy that the original ideas for miniature sonobuoys were developed during the late days of the Tracker aircraft, with dispensers in the rear of the engine housing. These trade-offs were being made during the time of the CALYPSO trials, with a number of improvements other than acoustic performance being realized. The sonobuoys of the day transmitted their information via a very high frequency channel to the aircraft on one of 31 dedicated channels. A great advancement was increasing the number of available channels to 99 so that channel congestion was minimized with multiple sonobuoys in the water. This was not as important for the Sea King as it was for maritime patrol aircraft at their higher altitudes. What was more important was that the sonobuoy transmitter frequency was selectable, and a new generation of sonobuoy receivers known as the AN/ARR-78 eventually replaced the AN/ARR-75s.

The trade-offs on size ultimately led to both the DIFAR and Bathythermal (used to measure water temperature at different depths) sonobuoys being produced in one-third the size of the standard sonobuoy. In Canada, the G-size Q-553G DIFAR and Q536 sonobuoys were specifically developed for Canadian helicopter use. They went into production in the early 1980s and continue in production today, with the best performing hydrophone on the market.

Another issue with sonobuoys was how to change their depth and life settings. A remote function capability was developed which would allow the reprogramming of sonobuoys by the crew while the sonobuoys were in their launch tubes, via infrared remote selection. However, this was never implemented. The radio downlink commands were now the only remote function select capability. The DICASS command function implemented on the CALYPSO programme was one of the earliest implementations of that capability in a helicopter.

These sonobuoy developments all occurred with the full participation of Canada in the sonobuoy working group previously mentioned; therefore; the mechanisms were all in place to not only shape the evolution of sonobuoy technology but also be part of the leading edge of the changes they brought.

Major Terry Burt was Commanding Officer (CO) of HOTEF during these trials, and with a very helpful Emerson team supporting, HOTEF began to put the system through its paces. However, Emerson was having no success in selling this capability to the USN despite intensive lobbying, as the USN had tied itself to their Proteus supplier and the tethered concept of operations. In one notable demonstration to mid-level USN staff in Patuxent River, Maryland, Burt's presentation was interrupted by a senior officer who arrived with "instructions from Washington" and even ordered the staff to give back the coffee mugs they had received as token gifts. This lack of USN support was to have considerable influence on the way ahead for Canada.

While this was happening on the Shearwater side of the Halifax Harbour, a different story was developing on the naval waterfront. Major Gunars Balodis had been appointed the CO of the Acoustic Data Analyis Centre (ADAC), a third line acoustic intelligence facility located in Halifax. ADAC had just received status as a joint maritime unit, neither Navy nor Air, having previously been part of the Admiral's staff. ADAC had just been equipped with the state of the art in acoustic analysis equipment and was ramping up to support the training of the new CP140 Aurora crews with the advanced equipment that they would have both on the aircraft and in the Data Interpretation Analysis Centres at Canadian Forces Bases Greenwood and Comox. Most importantly, ADAC, in addition to its training and third-line analysis role, took on the task of developing new tactics to exploit the signal processing and display capabilities of the Aurora. The ADAC officers were all maritime patrol navigators, with analysts from the Navy's Ocean Operator trade who came from the SOSUS sites, known as Naval Facilities (NAVFACs), and with Navy sonarmen who undertook the technical maintenance of the array of complex equipment that ADAC had. The senior technician was sonarman Petty Officer First Class George Dowler, outstanding in his ability to undertake the maintenance tasks his team was responsible for, but Balodis sensed that he was not entirely satisfied with his job. Finding an opportunity to delve further, Dowler confided that he was frustrated with the overall situation in the Navy. Unlike maritime patrol crews, naval officers had no training in passive acoustics and no tactical appreciation whatsoever in how to apply this capability. As a result, the sonarmen were only employed on the active sonar, were losing their passive skills, and feeling generally underutilized. Balodis had assessed that as a unit separate from the Admiral's staff, he could exercise more independent discretion. The result of that meeting was a provocative article in the *Maritime Warfare Bulletin*, which took the Navy officership to task—not in a negative way, but in promoting a new way of doing business. What the article promoted was the concept of the Destroyer Jezebel (DESJEZ) system.

The concept put forward by Balodis was disarmingly simple. We knew that in the deep ocean we could detect Soviet nuclear submarines with sonobuoys at long distances in an area known as convergence zones, which are typically 30 miles [48 km] from the sonobuoy where sound gets focused by the lens properties of the ocean in a band about 3 miles [4.8 km] deep. Our ships were equipped with the same AN/AQA-5 sonobuoy processors as on the Argus, and the antennas were mounted up on each ship's mast, with a reception range of about 12 miles [19.3 km]. The concept was that by dropping sonobuoys off the stern of the ship moving at slow speeds, the ship's noise was no longer masking the sonobuoy once they were about 4 miles [6.4 km] astern. By dropping the sonobuoys 3 miles [4.8 km] apart, the convergence zone coverage ahead of the ship had a width of about 9 miles [14.5 km].

The reaction that this received on the waterfront was quite amazing, with a small but steady stream of sub-lieutenants and lieutenants knocking on the doors at ADAC out of curiosity, and then given training. These included Lieutenants Eric Lerhe, Gord Fleming and Rob Burch, amongst many others. Although it was the young officers who appeared to be most attentive to the deficiencies in naval ASW raised in the *Bulletin* article, it was clear that it had also caught the eye of Admiral Fulton, then Commander of Maritime Command, and Admiral Allan. Their support from the top led to HMCS ANNAPOLIS being designated as an acoustics trials ship, and it wasn't long before Balodis and Dowler were at sea doing DESJEZ trials along with Lerhe and a very sceptical combat staff. However, once contact had been made during the submarine exercise, Balodis walked the floor between the sonar room where Dowler was and the plotting table and worked out the most probable position of the submarine. The officers of the watch nodded politely and carried on. When the green flare appeared shortly thereafter, they were believers. Things now started to move rapidly, with more trials and, most importantly, the capturing of the trials into the tactics bible for the Navy. If truth be known, most of the writing was done in Lerhe's apartment on Foston Street in Dartmouth during some long nights and several cases of beer. By this time, a highly engaged Maritime Warfare Centre was putting its not inconsiderable resources to the task.

There were other irons in the fire. The development of DESJEZ tactics was now having a demonstrable effect in other areas. Acoustic warfare, in every aspect, was relying on the knowledge acquired from immense investments in gaining a better understanding of oceanography. Sensor performance prediction against targets for which we could gain ever better intelligence was benefitting from a suite of prediction tools which were acquired from the USN and the National Oceanographic and Atmospheric Administration. These tools all needed to be introduced; training had to be developed and conducted. In 1978, the SEASAT (sea-satellite) oceanography satellite was launched, and we acquired the capability to process its infrared imagery of the sea surface temperature.

At the Navy's meteorological and oceanographic centre, work was feverishly underway to understand the Gulf Stream and the phenomena of eddy structures, which started to give insights into why acoustic performance was not working to predictions and, ultimately, gave us insights into how the Soviets might use these virtually impenetrable acoustic walls where the Gulf Stream and Labrador Current passed one another. For the first time, oceanographers were tasked with providing tactical support to embarked operations staffs.

All of this was to get ready for prime time; taking the first towed arrays to sea, the work of a decade of development at the Defence Research Establishment Atlantic (DREA). I will not go over the history of the development of the Canadian Towed Array Sonar System (CANTASS), for others have covered the subject; however, perhaps not in this context. The development of the signal processing at DREA, which became the CANTASS array processor, was the most capable and fastest processor of its kind anywhere. Mated with the US-developed SQR19 towed array, it originally went to sea on the Canadian Forces Auxiliary Vessel (CFAV) QUEST and then on HMCS FRASER, IROQUOIS, and NIPIGON. Although the early phases of the trials had been planned by DREA, no doubt in close coordination with the Navy, the success of these trials and the subsequent introduction of the equipment into operations could not have been accomplished without the completely unrelated activities taking place on the waterfront with DESJEZ and over in Shearwater with CALYPSO.

In 1982, I had a surprise posting from ADAC to Sea Kings. I had gone from the most dynamic, complex, state-of-the-art world of ADAC to what looked to me like the bottom of the barrel when it came to ASW. The curriculum was devoid of anything that resembled imparting an understanding of modern ASW. With the blessing of Major Doug Langton, the course director of our operational training unit course at 406 Squadron, I taught a revised oceanography and acoustics syllabus. The Falklands War was in 1982, and the sinking of the Argentinean cruiser *Belgrano* by Her Majesty's Ship *Conqueror* served as a reminder of the power of submarines as well as the stealth and speed of nuclear submarines, in particular.

Six months later, I was appointed the helicopter air detachment (HELAIRDET) commander of HMCS IROQUOIS. With the ship just coming out of refit, there were myriad things to learn: forming a new detachment, meeting a new ship's company, and understanding engineering issues, all with little time to think about what our ultimate job was. The sea trials programme was more about alarms going "bong-bong" in the middle of the night and dealing with damage control. Most disturbing to me was to learn that the ship's combat team had spent some considerable time in the warfare centre's simulator without their HELAIRDET. I was starting to wonder how this was all going to come together. In the day, the active dipping sonar and the ship's active sonar relied upon cookie-cutter tactics selected from a limited menu of pre-planned options.

The inevitable result was a green flare signalling yet another successful submarine attack. It had occurred to me that with the ship's sonar being considerably more powerful than the Sea King's sonar, perhaps passive listening on the helicopter sonar could give a better coverage area, something known as bistatic sonar; in other words, the transmitter and receiver are not collocated. After developing some initial thoughts, Captain Nigel Field, who had flown the CALYPSO while at HOTEF, became an enthusiastic supporter of the idea. He was a tactical control officer (TACCO) who, prior to commissioning, had been an avionics technician. He noted that the Sea King sonar receiver was not optimized for the lower frequency of the ship's sonar. The sonar lab in Shearwater, and my apologies for not having a recollection of the name, advised that they could retune the Sea King sonar receiver, the so-called heterodyning circuit, to better receive the ship's lower sonar frequency, and indeed did so. And so it was, on 17 January 1984, that we undertook some trials with a submarine and some newly developed tactics and actually received echoes in the aircraft. Ultimately, the problem was that without an accurate means to determine the location of either the ship or the helicopter, positioning the submarine would not be possible. We recognized that a global positioning system (GPS) would ultimately solve the problem, but it was too early. Armed with piles of charts and notes on how the trial had been conducted, our preliminary drawings on tactics, and the limited results, I marched over to SSO Engineering and Repair across the harbour. I was politely told that this was really of no interest to the Command and that they would be dutifully filed away. I have no idea whatever happened to that pile of paper, other than multi-static ASW became one of the major research and development thrusts within NATO within five years.

Meanwhile, lots of progress had been made with the towed array programme at DREA. The software had been built by Array Systems of Toronto to DREA's specifications and then militarized with the appropriate hardware by CDC. At this time, the towed array trials on board HMCS FRASER were being conducted with the Experimental Towed Array System focusing on ship integration issues and proving that the complex technology worked at sea. The success of these trials led to the planning of a much more ambitious trials programme, with the system to be installed on IROQUOIS, and it was not long after these initial ruminations about bistatic sonar that the scope of ambitions changed dramatically.

In order to fit the array and computing system onto the IROQUOIS, the ASW mortar and variable depth sonar had to be removed, and major changes were made to the aft end of the ship to accommodate the processing equipment. This, however, was just the more visible part of the task at hand. The IROQUOIS had originally been designed with a Prairie/Masker system, which lets out small bubbles of air from the ship's hull (Masker) near the machinery spaces to create a barrier to the sound escaping into the ocean. When screws turn above a certain speed, a small, vacuous bubble is created behind the blade, as the pressure there is lower than the vapour pressure at that depth. This is known as cavitation. Prairie is a technology to inject air from the tips of the screws into those bubbles; the effect is that when they collapse they emit much less noise. All of this effort was undertaken as part of a larger programme to lower the radiated noise of the ship, to improve the performance of the array, and to reduce the possibility of counter-detection. This was not an inconsiderable task; this was the first time that the crew all wore running shoes, and the ship was put through rigorous paces on the sound range. The considerable success of this effort led to requiring all ships to clear the sound range to certain parameters before they could be declared operationally ready. In that late spring of 1984, there was also a lot of training and tactics development underway. I had the task of teaching acoustics and oceanography to the combat team, while tactical development was underway at a furious pace at the Maritime Warfare Centre. With a detection on the array giving a bearing to a target and with a linear array also an ambiguous bearing, the relatively simple issue of how to resolve the correct bearing gave way to the much more complex issue of trying to determine the range of the submarine and its movement, so-called target motion analysis (TMA).

A side note, which there isn't time to delve into here, was the widespread use of hand-held programmable calculators, notably the HP67, 97, and 41 series, which allowed many of the necessary calculations to be made and programmed at unit level, including tax returns for the pilots while the rear crew were busy.

There were also a host of other considerations, including the complexity of how to deploy and recover the array and operate it effectively from an engineering and seamanship perspective. The ship's combat team also had the opportunity to go to Norfolk, Virginia, and take the USN's antisubmarine warfare commanders (ASWC) course, which was provided to the ASW commander and his crew prior to taking up their responsibilities on the carrier.

On the helicopter side of the house, things were no less interesting. In addition to learning about the new technologies, tactics and procedures on the ship, the unique ability of the DDH 280 to carry two helicopters led to some significant new thinking. The concepts and tactics of how to employ a passive and active helicopter started to bear fruit. With aircraft 410, the CALYPSO bird, and 422 normally assigned as the dipper, much work needed to be done, but the concept of employment was relatively straightforward.

Once a detection was made on the array, the passive Sea King would be readied for launch and the combat team would determine what the optimal steer would be for both the ship to get input to the TMA and the helicopter's wind envelope. With this turn, the bearing ambiguity would have been resolved, and the aircraft would fly down the bearing until it reached a point down range where, at the inner estimate distance of the submarine, it would lead the bearing motion slightly in the direction of estimated submarine movement and start dropping the directional DIFAR sonobuoys. Once the submarine was detected on the sonobuoys, the drops would continue until the DIFAR bearing on the target changed, at which point the active dipping aircraft would be launched with its weapons load. This combination, simple as it was, had a number of benefits. The passive aircraft would stay at a reasonable altitude, with a relatively low fuel burn and a good communications load, while the heavier weapon-carrying aircraft would optimize its fuel use. Once localized, the weapons carrier could then do an attack based on the passively derived location, if it was accurate enough, or enter the dip, lower its sonar and then execute the attack based on its own information.

Thus, we went off to sea in May of 1984 to see how it all would work. Tactics aside, we also had to deal with the problem of where to store the large inventory of sonobuoys and how to efficiently load them and ensure that the tactical procedures between the ships and the helicopter teams were fleshed out. In June, we finally got out against real targets—diesel and nuclear. The nuclear boat was equipped with a noisemaker, which not only made it easier to detect, but also masked some of the submarine's natural radiation, which was the boat's most closely guarded secret. In this case, the noisemaker was a real clanger. It didn't appear that you needed a towed array to detect her, but rather just put your ear in the water. Nonetheless, in these trials phases, a reliable target source was invaluable for validating our procedures. The diesel target certainly proved more elusive, and that was part of the challenge. What was more remarkable was that the array and the processor could detect and track all of the surface vessels, some to vast distances, except for sailboats, which still required a steady watch on deck. With this capability, the world of George Dowler was turned upside down. Now, the sonarmen were not only trying to find submarines, they were also keeping the entire surface plot, with a steady if not frenetic pace of activity in the operations room, and the ship was able to run silent throughout. The operation was running around the clock, and it just kept getting better and better. Dowler was the head sonarman on these trials, enjoying this new world immensely.

As the sun came up one morning in June 1984, aircraft 410 launched from IROQUOIS to localize the nuclear submarine. As the TACCO, I was doing my best to minimize my fumbling with the AN/ASN-123, which I had come to know through a 30-minute primer in the HOTEF laboratory. Master Warrant Officer Tom Banyard was operating the CALYPSO in a formidable fashion, despite my constant patter from the TACCO seat with unsolicited advice on how to optimize the numerous signal processing functions of the CALYPSO processor. Although the submarine was moving at a good clip, we finally started to get a feel for her location and intentions, and so, we called up the dipper. Aircraft 422 arrived on scene and got vectored in the dip, where Captain Don Blake put the simulated torpedo in the water within attack criteria on the first ping. We were 108 miles [174 km] from IROQUOIS; there is no evidence of this in the *Guinness Book of World Records*, but it is now out in the public domain to be challenged.

Out of gas if not ideas, 410 headed back to "mother" and landed; I headed up to the bridge. The combat team deserved some kudos, and so did the CO. HMCS IROQUOIS was perhaps uniquely blessed. Her CO was Commander Larry Murray and the Executive Officer Lieutenant-Commander Greg Maddison, both of whom would reach vice-admiral rank and exemplified the great leadership from which this whole endeavour benefited. Upon reaching the bridge, I saw Murray was in conversation with the Task Group Commander, Commodore Harwood, who had apparently landed shortly before us from the flagship HMCS HURON. Eavesdropping, I heard the conversation going something like this: "Larry, I'm the Commodore; I'm sailing on the flagship with my command team … and all I hear is IROQUOIS calling ProbSub [Probable Submarine], calling out attacks and we haven't got a clue what's going on. I wouldn't mind you letting me in on what's happening."

One of the significant tactical changes brought about by the towed array was that the conventional means of having warships steam in close formation around the high value unit, not unlike the convoy escort duties of WWII, was no longer viable. In order to ensure that ships' noise did not contaminate the arrays and that the array coverage areas were maximized, the so-called 4W disposition was developed. Now ships were separated to the distance of line of sight communication, covering a great area of the ocean and with all kinds of new considerations, not the least of which were area and local air defence coverage. It also meant that the distance the Sea Kings had to cover was considerably greater. And so it was that Murray had an asset which had turned the seas transparent, and we could not quite communicate the richness of this new-found world to the chain of command. But IROQUOIS was having a ball. Later on, things got more interesting. These developments are not for discussion in this forum, but one anecdote should suffice. One night, during the wee hours, life got particularly interesting; we had two USN officers on board from the Commander-in-Chief Western Atlantic (CINCWESTLANT) staff from Norfolk; they had contributed to that ASWC course that IROQUOIS had received. They soberly pointed out that without their ability to personally verify the performance of the CANTASS system, our reports would never have been believed back in Norfolk. Anecdotally, a year later, a new module had been added to the ASWC course called the future of ASW, built around the trials on board HMCS IROQUOIS.

A number of parallel efforts (for which there is no apparent evidence of a grand plan), the worldly ambitions of a highly capable world-class team of scientists, and decades of work were brought together with a Sea King that had been developed to explore new concepts: an array of related technologies from sonobuoys to oceanographic predictions. The Navy team, which had been energized by an article in a magazine resulting from a conversation with Dowler, and the broad education of a team of young naval officers and sonarmen with the development of DESJEX, were now ready to accept the CANTASS concept when it became ready for trials. As importantly, a steady but firm helm from the Commander of Maritime Command and MAGHQ encouraged and resourced this groundbreaking work. In only five years, the irrelevance of the Navy in ASW had been turned into the prospect of a dominant capability.

Back in Ottawa, changes were afoot. CDC had developed an airborne lightweight sonobuoy processor, with the unheralded label of SBP 1-1. It had some novel approaches to signal processing, but the critical operator interface was not as good as CALYPSO. Nonetheless, there was a desire to establish industrial centres of excellence (COEs), and the demise of CALYPSO in favour of the SBP 1-1 and a Canadian solution was in progress. It would be fair to say, in hindsight, that with the success of the Canadian-developed CANTASS processor, the advancements in sonobuoys with Canadian technology, and the overall success of the trials, the benefits have been realized. However, at the time, there was much more consternation amongst the maritime staff that a success story was now venturing into uncharted and risky territory.

At one point, Major Terry Burt, then CO of HOTEF, took the CALYPSO aircraft to St. Louis, where Emerson was located, to try to garner support. In Ottawa, Bob Cloutier, the CALYPSO project officer, and Brian Akitt at DMAEM tried valiantly to keep CALYPSO alive, but this was not supported by either Colonel Driscoll DMAEM or Colonel Read, Director of Maritime Aviation, as the industrial strategy was changing under Mr. John Killick, then Assistant Deputy Minister (Materiel) [ADM(Mat)].

The Sea King Replacement (SKR) project was starting to gather momentum and it was generally understood that the airborne passive processor needed to be integrated with a dipping sonar, something that did not exist at the time. This was the case for much of what SKR sought to achieve, which led to the approval of a portfolio of development projects, the last time that such an ambitious endeavour was undertaken in pursuit of a new weapon system in Canada. The HINPADS (Helicopter Integrated Processing and Display System) project was to develop a new data management system, and this was to be undertaken by CDC. It included HINS (Helicopter Integrated Navigation System), a unique GPS/Doppler/Inertial navigation system to be developed by Honeywell; AIMS, an advanced Magnetic Anomaly Detection system designed for helicopters by CAE (Canadian Aviation Electronics Limited); and HAPS (Helicopter Acoustic Processing System). By now, CDC had been designated the acoustics COE, and Driscoll directed Akitt to initiate a minor research and development project to buy an SBP 1-1 processor and put it in the HOTEF aircraft which already had the modifications—such as the tape recorder, DICASS transmitter and tactical navigation system—installed. From this SBP seed, the HAPS project grew and sold as part of the New Shipborne Aircraft (NSA) project.

As the COE concept was being developed within ADM(Mat), CDC was having difficulty selling its capabilities to DND. At the Shearwater Air Show in 1984, Derry Thompson, who was then the head of marketing at CDC, and Keith Patterson, an ex-Maritime Proving and Evaluation Unit (MPEU) officer now at CDC, met LCol Terry Doyle, who was then the base administration officer and probably best known for moving the weather-plagued air show from July to its current September time frame. However, he had been involved with the APOJI trials in his days at MPEU and knew his acoustics. Nonetheless, Doyle was able to get Derry a flight in an Aurora. To thank him, Derry hired Doyle when he left the service. His first job was to get feedback from HOTEF on how the SBP compared to CALYPSO. Although the comparison was not always favourable, the now more appropriately named UYS 503 was starting to get modified in response to the critiques. One of the key players in this dialogue with CDC was Captain Bruce Lewis, an Argus navigator who was at the Special Projects Unit at DREA and also had managed to do his master's degree in electrical engineering during that posting. The debates over the arcane concept of "slice processing" between Lewis and the Vice President of Engineering at CDC, Ron Trisnan, were intense and heated, but in the end, the UYS 503 became a solid sonobuoy processor. Doyle was the recipient of the call from Akitt to say that they were going to get the HAPS development contract.

HAPS came out of the CRAD NSA studies in the mid-80s. A key outcome of the studies was that the dipping sonar had to operate at much lower frequencies than the current sonar, and, therefore, needed to have a bigger antenna array. The system was designed to be the first integrated active/passive sonobuoy processor capable of integrating a dipping sonar. GDC was selected to develop the sonobuoy and active sonar processing system capable of processing 16 sonobuoys and a dipping sonar. Brian Booth, head of R&D at GD Canada was the project engineer and Chris Barlow was the project manager. The GDC product was interfaced with a developmental Plessey UK Cormorant 4-KHz sonar. Brian Harvey was the project manager at Plessey. Plessey subcontracted to Indal Technologies (Brian Morrow) for the winch for this sonar, which was going to go to much greater depths and at much greater speed than any previous dipping sonar. The contract was actually with Fathom Oceanologies, which was bought by Indal, who were already well known for manufacturing the Beartrap and RAST systems. A number of other issues were addressed which had been learned through CALYPSO but, perhaps were not as visible. For example, the original CALYPSO keyboard was somewhat ineffective in cold temperatures. The Sea King electrical generators provided rather dirty power, which digital processors did not like, and the rotor blades modulated the incoming sonobuoy signals.

The processing system was accepted at GDC and the sonar in the UK, and the whole package was delivered to Halifax in August of 1989 for testing at the DREA barge. The winch was mounted on the barge crane in order to lower and raise the transducer in and out of the water. Active processing testing was completed over the fall of 1989 using a near field transponder. One of many maritime-patrol navigators with acoustic expertise who had been transferred to the Sea King community, Major Bruce Lewis, was at HOTEF as the HAPS project officer responsible for conducting the testing. Major Rob Irving was the CO of HOTEF when the system was being conceived, with the command changing to Major Fournier in 1989.

The DREA barge was utilized for active testing of the processor, and the Plessey company's Cormorant sonar contained an office space, equipment storage and appropriate power to operate the equipment. In the centre of the barge was a large well that permitted acoustic testing to take place by placing sensors or transmitters into the water at one end of the well and either acoustic sources or transponders at the other end of the well. For the HAPS evaluation, the aircraft winch was located on the barge overhead crane support, some 20 to 25 feet (6.1 to 7.6 metres) above the well, with an aluminum ladder to permit access to the winch. The winch was fully powered and was used to lower the sonar into the water using the HAPS control panel. A transponder was used to receive, delay and retransmit the received pulse from the sonar in order to simulate targets at various ranges. Testing was carried out by Bryan Harvey (Plessey), Brian Booth (CDC); Sergeant Jeff Tupper was the HAPS operator, and Lewis was the HOTEF project officer. They were assisted by Glen Stewart, the barge operator, and members of the Service Projects Unit from DREA commencing in August 2000.

Operating on the barge was an adventure, particularly because, in the 1980s, raw sewage was dumped into Bedford Basin, resulting in interesting smells on the barge and sights in the well. On one occasion, Booth climbed the ladder to the winch, the ladder slipped slightly, and he had a choice of saving himself or his engineering notebook from falling into the water. The notebook lost and was fished out of the tank after a great deal of laughing by the team. To say the least, no one wanted to open it.

After some months of testing, the sonar suddenly failed and had to be returned to England for repairs, as the problem could not be found locally. When the sonar was taken apart, it was determined that all of the connectors had been corroded off, and the engineers could not explain what had happened. During a meeting with the connector vendor, Harvey showed the damaged connectors to the sales engineer, who pointed out that the damage was typical of what would occur on a ship, but he could not understand how this happened on a helicopter system. It turns out that the barge uses anodes/cathodes to protect it from corrosion, and instead of using the installed protection, the team had managed to sacrifice the sonar's connectors to protect the barge from corrosion. A very expensive lesson learned. In the summer of 1990, in parallel with the first Gulf War support, the system was installed on CFAV QUEST for evaluation in the Bras d'Or Lake (in Cape Breton, Nova Scotia)—Rocky MacManus was the project officer for the evaluation.

Unfortunately, HAPS did not survive past the prototype stage, and not unlike the Emerson processor, the Plessey Cormorant was at the end of its life as well. To add to the list of untimely demises, the UYS 503 installation was in aircraft 411, which saw its untimely demise in September 1989, having been ditched with a gearbox failure.

Doyle had left CDC for Leigh Instruments, a company owned by Plessey. Before he left, however, he had hired Balodis to head up the acoustics research team at CDC; Balodis was most pleased to leave Winnipeg, where he was looking after Hercules refuelers in the name of career broadening. Doyle was replaced at CDC by Floyd Bosko, a veteran Sea King pilot. CDC also hired Lloyd Noseworthy, a maritime-patrol navigator with a USN exchange tour under his belt, to market CDC's products into the US. He is known to many today as the Canadian project manager for Sikorsky for the Maritime Helicopter Project (MHP). Noseworthy ended up selling the UYS 503 to the USN (for the SH-2 Seasprite) and Royal Australian Navy (for the Seahawk).

More changes were in the wind in Ottawa. The further development of the Plessey sonar had been overtaken by the development of the Folding Light Acoustic System for Helicopters (FLASH) sonar by Thomson-Sintra in France and the Helicopter Long-Range Active Sonar (HELRAS) by L-3 in the US. Both of these sonars were being entered into the open competition for the NSA. Moreover, there were serious concerns in NDHQ that there needed to be a gap-filler between the current Sea King and the NSA to develop skills in acoustics and also as an interim operational capability to support the CANTASS system, which was about to enter service with the new HALIFAX class of frigates. The HELTAS (Helicopter Towed Array Support) project was conceived to provide a shipboard aircraft that possessed the capability for the passive redetection and tracking of contacts and was approved by the Program Control Board on 1 December 1988.

However, the road to the approval of HELTAS was a winding one. It had started out as a project to replace the ancient AN/ASN-501 tactical navigation system. It was not getting traction but was identified as a project concurrently with a replacement for the unreliable Doppler system. These got married up into something which was called the Sea King Interim Modification Project, or SKIMP. Then Director of Maritime Requirements Staff Programs, Commander J. Y. Forcier, astutely observed that the chances of a SKIMP project being approved were remote, and he suggested that HELTAS might be a more appropriate acronym. Jim Cottingham was the project director for HELTAS, with the task of getting the project scope defined and funded. In the end, the HELTAS project was constrained to six aircraft by the budget.

The scope of the HELTAS work was broad. It included removing the dipping sonar and installing the UYS 503, the AN/ASN-123, the CAE AIMS system, AN/ARR-75 sonobuoy receivers, an AN/ARC-164 UHF transceiver for DICASS commands, and various ancillaries such as a tape recorder and time-code generator. Amongst issues which were resolved were a magnetic compensation device to shield the magnetic anomaly detector (MAD) from the radar and magnetic degaussing of the main rotor blades.

It was thought that CDC would undertake this project. However, CDC had some concerns that not only did they have to deal with acoustics, but they also had to install this newfangled MAD on a Sea King, so they balked at accepting the risk of this work. Arch Connors, an ex-flight engineer at IMP Aerospace, looked over the project and, according to anecdote, said "we'll prime the sucker," and that was it. Such was how business was done in the day. The contract with IMP was signed on 30 March 1990, and the final CH124B designated aircraft was delivered in March of 1993.

All of this East Coast activity notwithstanding, the West Coast was not to be left out. In 1988, Captain(N) Garnett arrived on the West Coast as Commander Destroyer Squadron (DESRON) 2. His staff included Dan Murphy, George Prudat and Ed Tummers, who had previously been involved on the East Coast oceanographics work in support of DESJEZ. As importantly, 443 Squadron had relocated to the West Coast. Garnett and DESRON 31, located in San Diego, had a handshake agreement to conduct combined operations with the USN towed arrays and Canadian DESJEZ. Their concern was the so-called "black hole" in the Pacific where the Auroras could not reach. Major Barry Towill, a graduate school classmate of Balodis, was the command oceanographer to support these operations. The Sea Kings were embarked on HURON and PROVIDER, and off they went. The operations themselves will need to be discussed elsewhere, but the use of the DESJEZ expertise, the sonobuoy laying capacity of the Sea King, and the tactics developed on the East Coast all served well to support these critical operations against a very determined and capable adversary.

Commander George Prudat eventually took command of HMCS NIPIGON, the last Navy ship dedicated to trials work, when Garnett was Commander of MARLANT. The NIPIGON modus operandi was to stream the array on departing harbour, all emitters silent, lookouts on the bow, and full steam ahead. Capable and confident.

In this rather wide-ranging paper, we have seen how people, technology and processes converged from seemingly uncoordinated directions, as much the result of serendipity as that of any strategy or governing body, to create what is perhaps as capable an ASW capability as exists anywhere.

Most importantly, the Navy—and the Sea King as an integral component of its warfare capability—was transformed by groups of dedicated working people in the research, operational, and industrial communities to create a credible counter to the devastating possibilities of nuclear annihilation during the cold war and lay the foundation for countering an equally formidable diesel submarine threat posed by the many countries that have them today, the definitive asymmetric weapon for those unprepared to deal with them. The Soviet Navy had become a powerful capability which threatened the West, but our collective efforts to counter that threat had taken effect.

And so, a footnote: the current acoustic processor installed on the Aurora and the integrated active/passive dipper for the Cyclone have roots in work led by both Dr. Bob Walker and Steve Davies from DREA in the 1970s and 80s as well as the HAPS project. The scientists proposed a new signal processing scheme that removed many of the time bandwidth issues of the current sonobuoy processing systems which, when combined with lessons learned and developments from HAPS, produced the current product line.

Starting with CALYPSO, then the SBP1-1, HAPS and HELTAS, the trials of the CANTASS system and its subsequent introduction to service led to the need to upgrade the airborne processor technology. In the early 1990s, the Aurora Project Management Office contracted with GDC to develop the Modular Virtual Memory Expansion (VME) acoustic processing system (MVASP) prototype, which was followed by the production of the MVASP system now incorporated into the Block III Aurora Incremental Modernization Program (AIMP) modified Aurora aircraft. This system was combined with the HELRAS dipping sonar by GDC and is being delivered to DND on the Cyclone aircraft.

So, we can conclude that as we celebrate the 50th anniversary of the Sea King, the body of work that started 35 years ago is now being realized with the delivery of both the Cyclone and the Block III Aurora to put Canada once again at the forefront of ASW capabilities anywhere.

Notes

1. SOSUS was a system of sea-bed mounted hydrophone arrays located in different parts of the world and connected to nearby shore facilities using underwater cables. Located in areas that optimized long-range acoustic signals, it provided a covert surveillance system for monitoring submarines. Work began on what would become SOSUS in 1949 with the system becoming operational in 1961.

2. John Anthony Walker was a former US Navy Chief Warrant Officer and communications specialist, convicted of spying for the USSR from 1968 to 1985.

3. The Fast Fournier Transform (FFT) was popularized by J. W. Cooley and J. W. Tukey, two American mathematicians, in 1965.

4. VX-10 stands for Heavier-than-Air (V), Experimental (X) Squadron No. 10. It was formed in 1953 and was absorbed into the Canadian Forces Aeronautical Engineering and Test Establishment (AETE) in 1970.

Mark Aruja

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Mr. Aruja's operational military career encompassed both fixed- and rotary-wing maritime aviation with command appointments at squadron and wing levels. He has over 3,000 flight hours as a tactical coordinator.

In his formative years, he learned the arcane art and science of acoustic warfare flying on the Argus. He served as the research officer at the Acoustics Data Analysis Centre developing tactics and techniques for the new Aurora aircraft, conducted trials at-sea on both ships and submarines introducing new equipment and techniques and taught various courses such as digital signal processing. He served as the Sea King Detachment Commander on IROQUOIS for two years, notably under the leadership of Commander Larry Murray and Lieutenant-Commander Greg Maddison. During that time he was privileged to be able to assume a leading role in planning and executing towed array trials and the development of combined passive/active helicopter tactics in antisubmarine warfare.

Staff appointments included Operational Requirements Manager for the New Shipborne Aircraft project, Deputy Chief of Staff Personnel at Air Command Headquarters, and a secondment to Estonia as the Chief of Staff of the Estonian Air Force, where he initiated the Baltic air defence system known as BaltNet. At National Defence Headquarters, he was the Director of Space Development and the first appointee to the positions of Director General Joint Force Development and Commandant of the Canadian Forces Experimentation Centre.

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Chapter 6

Rethinking Maritime Air: Preparing and Maintaining Canadian Sea King Helicopters for Operations in the Persian Gulf 1990–1991

Richard Gimblett

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The Persian Gulf deployment of 1990–1991 was a defining moment in the Canadian military experience. This paper will take certain instances from that crisis to illustrate the way we handle organic maritime air—that is, embarked helicopters at sea—in the Canadian Forces. I will proclaim my bias right now, as that of a naval officer having served as the combat officer of Her Majesty's Canadian Ship (HMCS) PROTECTEUR in the Gulf. That, I hope, is tempered by having been one of the official historians, and having had full access to the written record and numerous interviews.[1]

When Saddam Hussein invaded Kuwait on 2 August 1990, he could not have anticipated the scale of the reaction of the world community. Within a few weeks, a vast range of 35 nations had been assembled against him under United States (US) leadership and the auspices of the United Nations (UN).

Among the earliest of those joining the Coalition, Prime Minister (PM) Brian Mulroney announced the Canadian response on 10 August: two destroyers, HMCS ATHABASKAN and TERRA NOVA, and the supply ship PROTECTEUR, with their embarked Sea King helicopters, would deploy to the Gulf region in an operation codenamed FRICTION "to deter further Iraqi aggression."[2] This imprecise mission statement reflected the uncertainty over just what the government hoped to achieve by the deployment, but the early selection of a naval Task Group, instead of an army brigade or an air force fighter squadron, defined the Canadian response. Although supportive of the United States in the broad aim of halting the further spread of Iraqi forces into Saudi Arabia and evicting them from Kuwait, Canada was not prepared to become directly involved in the active defence of the Gulf States, or in American offensive operations to restore the previous regional order.

Instead, the Canadian government was acting under the auspices of the UN, where, at that time, Canada held a temporary seat on the Security Council. With the thawing of the cold war, the members of the Security Council were working in rare unanimity not to interfere with the US deployments underway for Operation DESERT SHIELD, but at this point they were agreed upon only imposing sanctions to demonstrate the world's displeasure. On 25 August, the day after the Canadian Task Group sailed from Halifax, the UN passed Security Council Resolution 665, calling for the maritime embargo of Iraq.

You will note the two-week delay between the Prime Minister's announcement and the date of sailing. Mr. Mulroney had qualified his remarks with the observation that the Task Group would get underway "as soon as necessary preparations are undertaken."[3] The rust-out of the Canadian Navy through the 1980s is well documented elsewhere. For our purposes, it suffices to note that the ships were basically armed and fitted for their established North Atlantic Treaty Organization (NATO) mission of anti-submarine warfare (ASW) in the North Atlantic Ocean. To meet the challenges of the much hotter environmental and operational climate which would be faced in the Persian Gulf, the ships would have to be fitted to operate in the anti-surface warfare (ASUW) and the anti-air warfare (AAW) roles. Extensive re-equipment was required. Even before the official announcement was made, detailed plans were worked out between the naval staffs in National Defence Headquarters (NDHQ) and those in Maritime Command (MARCOM) headquarters in Halifax. Anti-submarine mortars were removed from the destroyers and replaced with Phalanx Close-in (anti-missile) Weapon Systems. Harpoon surface-to-surface missiles were strapped on to TERRA NOVA, and all three ships were installed with new chaff and satellite communications systems.

As Mr. Mulroney spoke to the nation, the Dockyard was already in motion, and the next two weeks, from 10 to 24 August, witnessed a whirlwind metamorphosis of the three ships. If fortune had any role to play in the process, it was that practically all of the new weapons and systems were available from Canadian sources, awaiting installation in the new-construction ships of the Canadian Patrol Frigate (CPF) programme, or for refit under the TRUMP Tribal-Class Update and Modernization Programme.

A similar but separate effort was underway to prepare the helicopters which were to embark on the ships. The upgrade process of the CH124 Sea Kings, although smaller in scale, was no less sweeping in its purpose, also literally turning the mission orientation of the helicopters upside-down. However, it started somewhat after that of the ships. At that time, Maritime Air Group (MAG) Headquarters was co-located in the MARCOM Headquarters building, with the Commander of MAG double-hatted as MARCOM's Chief of Staff, Air (COS AIR). Like so many others that summer, Brigadier-General Barry Bowen was new in his position, having assumed command in July. Upon his return to Halifax on Tuesday, 7 August, from a tour of his West Coast forces, Vice-Admiral Bob George, the commander of MARCOM, advised Bowen of the possibility of the naval option. Although any such deployment would include embarking helicopters, contrary to the staffing of the ship preparations, which was already well underway by that time, the need to examine the role of the Sea Kings did not generate much activity until two days later, when notice of the NDHQ Warning Order was received, apparently because "no one told MAG until just prior to the PM's announcement!"[4] General Bowen was left thinking of the whole matter of a deployment as only an abstract possibility.[5]

In part, this was due to the sensitive nature of the planning at that stage and the need for tight security; indeed, the lack of activity in MAG was consistent with that in MARCOM itself, where few persons outside the offices of the Chief of Staff for Operations (COS OPS, double-hatted as CANCOMFLEET), and Commodore Ken Summers, the designated task group commander, were aware of what was transpiring. It was more a reflection of the fact that all of the early planning effort on Operation FRICTION was centred in NDHQ, where the early emphasis on the naval option caused several factors to work against the inclusion of maritime air concerns in the staff estimation process.

Paramount was the fact that MARCOM had been identified as the lead command for the operation. But even so, the organization of NDHQ and the Canadian Forces allowed for a definite oversight in the planning process. Within the air community, Maritime Air Group had long been the poor cousin to Fighter Group and Air Transport Group; the Directorates of Maritime Air Requirements (DMA) and of Maritime Air Engineering and Maintenance (DMAEM) did not carry the same weight within the staff of the Chief of Air Doctrine and Operations (CADO) as the Directorates of Naval Requirements (DNR) and of Maritime Engineering and Maintenance (DMEM) did within the Chief of Maritime Doctrine and Operations (CMDO). It is also significant that DMA was not included by CMDO in the early naval (DNR/DMCS/DMEM) staff discussions. Given the physical location of DMA (near the Directorate of Maritime Force Development [DMFD]) within NDHQ, this was regrettable.[6] The problem was exacerbated by the fact that, even with Commodore Summers in constant touch with his Ottawa counterparts, no one thought of establishing a similar process for General Bowen.

And there is yet another dimension to this whole problem in the air community. Even at this early stage in mid-August, Air Command was already exploring the possibility of sending a squadron of CF18 Hornets to the Gulf (which eventually did come to pass, to fly protective Combat Air Patrol top cover for the ships), and this was occupying their staffing efforts. That did not prevent Air Command HQ from complaining quite strongly after the fact that "[AIRCOM itself] was excluded from the preparations for deployment of the Naval Task Group ... [which] prevented arbitration of priority conflicts and resource allocation within NDHQ."[7] At all levels, there seems to have been little thought given to the Sea Kings, beyond the fact that they would embark on the ships as they customarily did for all major deployments.

Once the overt preparation process was finally put in motion with the NDHQ Warning Order of Thursday, 9 August, MAG awoke quickly to the fact that this was anything but a "come-as-you-are" party as far as the helicopters were concerned. Already well behind in the preparation definition, the absence of a specific mission statement from either NDHQ or MARCOM led to a further delay while MAG grappled to define a concept of operations for the aircraft. At the preparation coordination meeting the next day, on Friday, 10 August, Commodore Summers indicated that the primary role should be focused towards surface surveillance, a role far removed from the ASW mission for which the Sea Kings were equipped.[8] The rest of that day and Saturday were devoted to further defining the new role and identifying equipment required to change the ASW Sea Kings to meet the new tasking.

Fortuitously, General Bowen had just relinquished command of Canadian Forces Base (CFB) Shearwater, where the Sea Kings were based, and he had been associated with maritime aviation for many years. Still, it was not until Sunday that MAGHQ was able to announce its intended response to the tasking,[9] a full six days after the surface world had gone through the same process, and with the preparation of the ships already well underway. The primary role would indeed be surface surveillance, but the helicopters would also be expected to undertake an important secondary logistics function known as "HDS," or Helicopter Delivery Service. At the same time, the commitment to the Task Group of five aircraft from HS 423 Eagle Squadron was elaborated in the Helicopter Air Detachment (HELAIRDET) allocation: ATHABASKAN would sail with a standard destroyer helicopter carrying (DDH) 280 HELAIRDET of two aircraft; PROTECTEUR would embark an "augmented" area of responsibility (AOR) detachment of three Sea Kings (vice the normal two), with an "enhanced" maintenance detachment for better support for an extended period away from the home base (the smaller TERRA NOVA was not built to embark helicopters). Although Commodore Summers already had an air officer on his flagship staff, the profile of the air component would be assured by embarking the commanding officer of HS 423, Lieutenant-Colonel Larry McWha, as an Assistant Chief Staff Officer.

As the role of the helicopters was being defined, the process of identifying needed modifications proceeded in tandem. It unfolded in almost exactly the opposite fashion as for the ships, which had been conducted for all practical purposes by NDHQ. Instead, staff officers from MAGHQ, in consultation with senior officers of 423 Squadron, hastily prepared an estimate of needed improvements to the aircraft. For some years, naval exercises had simulated surface search techniques, but little existed in the way of formal doctrine. As well, many of the self-protective deficiencies of the Sea King were well known, but the rectifications had not been identified. The necessary new equipment acquisitions had been deferred to be incorporated in the new shipborne aircraft (NSA) Sea King replacement programme.

NSA was supposed to be the naval air complement to the CPF and TRUMP programmes. Even in its ultimately scaled-down version, it represented a quantum advance in the capabilities of shipborne helicopters for the Canadian Navy. Besides improvements in ASW, the airframe of the projected EH101 aircraft allowed for significant surface surveillance capabilities, as well as a measure of self-defence. The statement of requirements for the NSA Project now provided several of the solutions to the immediate problems, but many more were the result of intense brainstorming sessions.

By Sunday morning, the small group of officers had put together a detailed list of the equipment anticipated to be necessary for the conduct of operations in the militarily and meteorologically hostile environment of the Gulf. The report identified 11 major systems to be fitted to the aircraft (see Table 1):[10] five for the new surface surveillance role, comprising a forward-looking infrared surveillance device (FLIR), stabilized binoculars, a light machine gun, and improved navigation (GPS) and communications (Havequick) outfits; and, six required for self-protection (referred to as aircraft survivability equipment, or ASE), ranging from chaff and infrared countermeasures dispensers to radar and laser warning receivers. (Note that in the latter category, the only system not listed in the table is the AWR-47 MAWS [Missile Approach Warning System], which will be discussed later.) The scope of the modifications was so extensive that the aircraft were given the unofficial designation CH124C; officially, they retained their CH124A status.[11]

If the refitting of the Sea Kings was simplified by the fact that only one aircraft type (as opposed to three unique ships) streamlined the design and installation process, it was complicated by the stringent requirements of flight safety.[12] Essentially, nothing being installed on the ships would make them sink, but electromagnetic interference (EMI) with certain delicate aircraft controls could literally make a helicopter fall out of the sky. However, Maritime Air Group did not possess the resources to undertake extensive aircraft modifications; Shearwater's BAMEO (Base Aircraft Maintenance Engineering Officer) organization was geared to the maintenance of the in-service helicopters and there was no on-site engineering and production equivalent of the Dockyard's Naval Engineering Unit and ship repair unit. Instead, all aircraft design production was coordinated through the engineering staffs of NDHQ and evaluated by the Aerospace Engineering Test Establishment (AETE). As such, whereas DGMEM played essentially a supporting role to the ship refits, Director General Aerospace Engineering and Maintenance (DGAEM) became actively involved at this point, taking direct control of the implementation process.[13] It is important to note that once again this was the opposite of DGMEM's involvement, where DGMEM had spearheaded the identification of the new ship equipment and then supported its implementation, and DGAEM had not been part of the initial aircraft equipment staff work.

At any rate, on 13 August, an on-site Installation Control Team (ICT) was established under the lead of officers from NDHQ's Directorate of Maritime Aircraft Systems Engineering,[14] and included additional teams of aeronautical engineers from the Aerospace Maintenance Development Unit (AMDU) from CFB Trenton, and the Aerospace Engineering Test Establishment (AETE) at CFB Cold Lake. The aim of this group was to avoid any circumvention of the existing tried and proven installation and test procedures. Instead, they determined that the normal procedures could be modified to the extent of compressing the timeframe by integrating the two activities.[15] Essential to this was the early decision to refit a total of six aircraft.[16] The sixth would actually be the first completed, the idea being that the new systems would be fitted and tested in this "prototype" first to resolve any installation problems and then retrofitted in the remaining five aircraft. A further benefit of this was that the sixth aircraft, which remained in Canada, was available for later detailed testing, such as radar cross-section (RCS) measurement, and trialing of new tactical developments, advantages which were not available to the ships.[17]

Although Shearwater's effort initially lagged behind that of Dockyard by a full two days, it very quickly reached the same level of intensity. Even while the lists of new equipment were being put together, the air maintenance section at Shearwater was busy removing such obvious surplus equipment as the dipping sonar. Meanwhile, the procurement staffs in Ottawa set about assembling the required systems. Some were in stock, literally scavenged from Hornet and Kiowa aircraft, but the bulk had to be purchased new. The MARCOM coordination meeting on the afternoon of 15 August was crucial. By that time, it was clear that the scope of the ship preparations had been underestimated; as well, General Bowen admitted that most of his items were still coded "red."[18] He estimated that one aircraft would be ready for the planned departure on the 21st, and the ground crews would "[d]o the rest on the way."[19] With the ships facing similar problems, it was decided that there could be no compromise on the installation of the new defensive equipment. The work period would be extended and sailing delayed by at least three days.

With the arrival of the Installation Control Team, the changeover got into full swing. Test flights of some of the individual systems began on the afternoon of 16 August,[20] and ICT activity ceased with completion of the prototype aircraft on the 20th.[21] Of the originally intended installations, only the AWR-47 MAWS proved technically unmanageable, with the aircraft being "fitted for but not with… [pending] further prototype investigation," which was never completed.[22] The early concern over EMI was proven out when the ALQ-144 infrared jammer "was found to create aircraft heading errors of up to 130 degrees!"[23] Its operational employment was restricted for some time before the Defence Research Establishment in Victoria proposed a workable solution in September.

Still, MAGHQ was able to boast on the 21st, the originally planned sailing date, that its installations were complete, and that "[e]ighteen months of peacetime work has been accomplished in eight days."[24] With the delayed departure date working to MAG's further advantage, the final maintenance checks and acceptance test flights were now completed and the last aircraft was signed over to HS 423 on the 23rd.[25] Only minor housekeeping work and familiarization checks remained for the ground crews and aircrews to undertake on the way to the Gulf.

Having obtained a suitably upgraded organic air capability, the Canadian Task Group came close to having to do without it. This situation arose in late October, over the issue of replacement of the Task Group. The decision reached by NDHQ was that the cost of refitting three more ships and five additional helicopters would be prohibitive, and crews would be rotated instead.[26] This had profound operational implications, quite aside from the obvious withdrawal of each of the ships from patrol in sequence while the changeovers were affected. Unlike the air task group in Doha, which frequently rotated CF18s from the Canadian bases in Germany, 423 Squadron had no practical way to transport replacement aircraft to the Gulf without a relieving task group. On top of that, back in August, even as the upgrades were being undertaken at Shearwater, MAGHQ had predicted that, with the projected flying rate (proven in actual operations), "[a]ircraft technical requirements in terms of maintainability/sustainability [would be] problematic ... [and] there will be a requirement for one in-theatre periodic inspection per aircraft during a possible six-month deployment."[27] Although direction had been requested from DMAEM, none had arrived.

Now, the problem of diminishing aircraft flying hours reached a crisis, and the investment made in the augmentation of the air maintenance detachment aboard PROTECTEUR reaped its dividend. In the short term, the afloat technicians had proven equal to the task of routine maintenance, keeping all of the aging and temperamental Sea Kings on the ready roster for an astounding 98 per cent availability,[28] but the necessity for periodic inspections presented a longer-term problem. A regular 20-day-long maintenance routine was required for flight safety reasons on all aircraft every 500 flying hours, and this was a major undertaking involving specialist technical support. Significantly, one had never before been conducted away from home base, let alone on a ship at sea. Together, the five task group helicopters were averaging 12 hours flying per day, or over 350 hours per month. The pace had been determined in part by the intention that the Task Group would return to Halifax in the early months of 1991. At the beginning of November, the total hours remaining were just over 1,250, sufficient to carry through to mid-February at the present rate, which in wartime was expected to rise.

Knowing now that there would be no replacement of the ships or their embarked aircraft until the summer of 1991 at the earliest, the initial reaction of Lieutenant-Colonel McWha was to order a drastic reduction in the hours flown by the air detachments. Henceforth, they were to fly only when necessary and otherwise remain at alert status, but that was only postponing the inevitable. Other than waiving the periodic inspection requirement, there was no alternative to in-theatre inspections. The situation was forced on 5 November when an airframe crack was discovered on one of the aircraft, "grounding" it aboard PROTECTEUR until a specialist metal technician from Shearwater could arrive to effect the repairs. Urgent communications passed from the task group ships at sea to the Canadian theatre headquarters in Manamah and thence to Shearwater and Ottawa, resulting in the decision to take this opportunity simultaneously to begin the 20-day routine on the stricken helicopter immediately.[29]

The only outstanding issue was where to undertake it. Both the US and Royal Navies also operated Sea Kings in the Gulf, but they were attached mostly to shore units, and there were sufficient differences between the models that making use of their facilities was not a viable option. In fact, PROTECTEUR's facilities surpassed anything readily available elsewhere in the Gulf for the Sea Kings, and the embarked maintenance team was quickly set to the task. With their effective confinement on board because of the patrol schedule, the first inspection took only 15 days, and subsequent ones were reduced to 12 days.[30] A sequence was worked out to have the remaining aircraft completed by February, which, with judicious scheduling and barring the outbreak of hostilities, would leave the five aircraft sufficient flying hours to resume the accustomed rate and support task group operations well into 1992.[31]

In the event, those plans, too, had to be changed. War did break out after the expiration of the UN deadline for Iraq to withdraw from Kuwait by 15 January 1991, and the exigencies of active operations forced NDHQ to re-think the rotation issue. HMCS HURON, the West Coast DDH 280, was refitted in Halifax and embarked the original prototype Sea King for despatch to the Gulf. Meeting the returning Task Group in Gibraltar, she picked up one of those aircraft to round out her HELAIRDET pair.

So, what are we to make from the pictures cast here? Both situations—the come-from-behind upgrading of the Sea Kings and then the shipboard undertaking of their in-theatre periodic inspections—arose and were allowed to develop to a crisis point essentially from the natural conservatism of peacetime staffing practices. From one perspective, their resolutions each seem perfect illustrations of the triumph of our good old Canadian "can-do" spirit. And so they were. But is this a good thing? From an opposite perspective, one might just as easily see a service which hangs by a thread as precarious as the fortuitous combination of the right individuals at critical instants.

Is this really a sound foundation from which to launch future operations? Our people, and with a little care, even our aging equipment, are top-notch and respond well when called upon. Can we rely on the hope that enough of those people will be in place, or that the state of our equipment will be conducive to an appropriate response when the next crisis arrives unannounced?

We must establish and work from sound principles that will withstand the rigours of crisis response. Will maritime rotary-wing aviation receive any better attention under the present reorganization of the Air and Maritime Staffs? If it makes sense in war, why should it not make sense in peace? Whatever the issue, it deserves more than last-minute, ad hoc treatment.

SYSTEM/WEAPON	FROM	USE	DESCRIPTION
FLIR 2000 (Forward Looking Infrared)	NEW	ASUW	A thermal imaging system to enhance night surveillance capability.
STABILIZED BINOCULARS (FUJINON Model S1040)	NEW	ASUW	Gyro-stabilized binoculars used to identify surface contacts at extended ranges.
GPS (Global Positioning System)	NEW	ASUW	A worldwide day/night all-weather navigation system which uses satellite information to calculate accurate positions.
HAVEQUICK	NEW	COMM	UHF secure voice radio.
ALQ-144/M130 (Infrared Countermeasures)	NEW / STOCK	ASE	Protects against infrared heat-seeking missiles; in conjunction with the M130 flare dispense system, decoys incoming infrared missiles away from the helicopter.
APR-39 (Radar Warning Receiver)	STOCK	ASE	A passive omni-directional radar receiver used to warn aircrew of radar controlled missile threats.
ALE-37 (CHAFF Dispensing System)	STOCK	ASE	Dispenses CHAFF to deceive incoming radar guided missiles.
LWR (Laser Warning Receiver)	NEW	ASE	Detects and alerts aircrew of laser energy being directed at the helicopter.

SYSTEM/WEAPON	FROM	USE	DESCRIPTION
NVG (Night Vision Goggles)	NEW	ASUW	An image intensification device which amplifies ambient light to allow visual detection and identification at night.
C-9 LMG (Light Machine Gun)	STOCK	ASUW/ ASE	Provides a self-defence capability.

Table 1: Sea King Equipment Upgrades for Operation FRICTION

Notes

1. Unless otherwise indicated, all primary source material is held in the collection of the Directorate of History and Heritage (DHH) at National Defence Headquarters in Ottawa. Although not yet declassified for general reference, the author had full access as one of the official historians, and citations are provided. Portions of this paper appear in slightly revised form in Jean H. Morin and Richard H. Gimblett, *Operation Friction: The Canadian Forces in the Persian Gulf, 1990–1991* [titre français, *Golfe Persique: Le rôle joué par les Forces canadiennes. Opération Friction, 1990–1991*] (Toronto: Dundurn Press, 1997), and are presented with permission. The views expressed herein are those of the author and do not necessarily reflect those of the Department of National Defence or the Canadian Forces.

2. Canada, Office of the Prime Minister, "Speaking Notes for Prime Minister Brian Mulroney Press Conference, National Press Theatre, August 10, 1990."

3. Ibid.

4. War Diary (WD) NDHQ, "Operation FRICTION Brief, Central Region MARE Conference," 31 October 1990, 4; and Operation FRICTION miscellaneous files, MARCOMHQ / Deputy Chief of Staff (DCOS) READ / senior staff officer (SSO) Committee of Staff Representatives (CSR), "Operation FRICTION Action File: Minutes of COS OPS Coordination Meetings," August 9 and 10, 1990.

5. Brigadier-General Bowen, telephone interview with author, October 22, 1991. See also, Peter Charlton and Michael Whitby, "Certified Serviceable," in *Swordfish to Sea King: The Technical Story of Canadian Naval Aviation by Those Who Made It So*, eds. Peter Charlton and Michael Whitby (Gloucester, ON: CNATH Book Project, 1995), 411.

6. WD NDHQ, "Operation SCIMITAR/FRICTION - Lessons Learned," 3350 OP-FRICTION ([Air] [Command] Comd), June 19, 1991, 6, 10, comments that this situation did not improve with the later introduction of the J-Staff: "Neither J3 Coord Air nor the J3 Coord Mar included any Maritime Air expertise. This caused several CH124 initiatives to be questioned or challenged without a valid basis…. This occurred in spite of the availability of DMA staff to provide input." Ibid.

7. Ibid., 2, 10.

8. Minutes, COS OPS Coord Meeting, August 10, 1990; confirmed in MARCOMHQ COS OPS 069 112206Z August 1990, "CTF 302 Tasking Order."

9. MAGHQ COMD 12002 122032Z August 1990, "OP FRICTION SITREP 001."

10. HS 423 SHEARWATER HS160 120700Z August 1990, "OP FRICTION - Operational Equip Rqmt."

11. LOGCON OTTAWA DMAEM 232275 021622Z October 1990, "OP FRICTION Aircraft Designation."

12. See Captain M. M. Korwin-Szymanowski, "AETE Support of Operations in the Persian Gulf," *Flight Comment* 1992, no. 1, 22–24.

13. Treasury Board of Canada Secretariat (Stephen Tsang coordinator), "OPERATION FRICTION: Refitting Three War Ships for the Persian Gulf - A Success Story in Materiel Management," September 1991, 8.

14. Ibid.

15. Ibid.; AETE Cold Lake AETE CO 649 141535Z August 1990, "Acceptance Comments PD 90/22 - OP FRICTION Installation Control Team Support."

16. MAGHQ COMD 12002 122032Z August 1990, "OP FRICTION SITREP 001."

17. Detailed RCS measurements of the modified CH124 were conducted from Osborne Head in the 29 August–07 September period, where the author was then on staff as Range Operations Officer and had a coordinating function. See NDHQ DMA 116 242003Z August 1990, "Visit Clearance Request."

18. As a means of tracking the progress of the installations, all three headquarters (NDHQ, MARCOMHQ and MAGHQ) adopted a format in which each major item was listed and then updated daily with an identifying code of "green" (low risk, and no known impediment), "yellow" (medium risk), or "red" (high risk). See MARCOM / DCOS READ file, "Operation FRICTION Background," for the "System Status Report, Operation FRICTION" as presented by Commander Summers to the NDHQ high-level Daily Executive Meeting, 15 August 1990.

19. Minutes, COS OPS Coord Meeting, 15 August 1990.

20. MAGHQ COMD 139 162110Z August 1990, "OP FRICTION SITREP 005."

21. MAGHQ COMD 146 202005Z August 1990, "OP FRICTION SITREP 009."

22. MAGHQ COMD 142 181932Z August 1990, "OP FRICTION SITREP 007."

23. Korwin-Szymanowski, 24.

24. MAGHQ DCOMD 227 211045Z August 1990, "Operation FRICTION - CH124A Modifications, Personal Equipment and Pre-Deployment Briefings."

25. MAGHQ COMD 153 222006Z August 1990, "OP FRICTION SITREP 011."

26. MARCOMHQ, "OP FRICTION Phase Two Tasking Order," 17 October 1990.

27. MAGHQ COMD 13001 132049Z August 1990, "OP FRICTION SITREP 002."

28. Charlton, 427–28.

29. CTG 302.3 051720Z November 1990, "CH12417 Periodic Inspection."

30. WD PROTECTEUR, 17 November 1990; and WD CTG 302.3, General Correspondence, Serial No. 091: "CH12417 Operation FRICTION Periodic Report," 3350-1-1 (AOR 509) (B2), 21 December 1990. See also, Charlton, 424.

31. CTG 302.3 052125Z November 1990, "CH 12417 Periodic Inspection," and CTG 302.3 071521Z November 1990, "CH-124C Flying Hours - A/C Stagger - Helo Ops."

Richard Gimblett

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Chapter 7

Ready for War: Modifications to the CH124 for Operation FRICTION

Terry Robbins

Introduction

It was the summer of 1990. The cold war was over, the Berlin Wall had fallen, and the Western world was looking forward to its peace dividend. Then, on 2 August, Saddam Hussein decided to right a historic wrong and redraw the Iraq/Kuwait borderline.

On Friday, 10 August 1990, Canadian Forces Base (CFB) Shearwater was issued the warning order to commence preparations for Operation (Op) FRICTION, which would entail the deployment of Sea King helicopters and helicopter air detachment (HELAIRDET) personnel on board Her Majesty's Canadian Ships PROTECTEUR and ATHABASKAN to take up trade embargo patrol duties in the Persian Gulf theatre by mid-September. What followed was an extensive 10-day period of aircraft modifications and other detachment preparations as well as significant airhead support activity for the Navy preparations. This paper will attempt to describe the important mobilization events of that period, with emphasis on the aircraft modification work.

The first significant task was to decide on the roles, missions and aircraft configuration for the operation. This went on over the weekend of 10–12 August 1990 in "active" consultation with Maritime Command (MARCOM), Maritime Air Group Headquarters (MAGHQ) and National Defence Headquarters (NDHQ). Unlike the Navy, who basically had all the desired kit (albeit by robbing the Canadian patrol frigate [CPF] and Tribal Class Update and Modernization Project [TRUMP] programmes), the Sea King had neither self-protection gear nor effective surface-surveillance mission suites available to it or even conceived for it. The mandate then was to explore price and availability as well as to procure, ship, design, manufacture, prototype, install, test, evaluate and deploy some 11 major and a number of minor modifications on the Sea King in just under two weeks.

It was rapidly apparent that the goal was not achievable unless a team was in one place and their collective effort concentrated and applied in innovative ways. Hence, the idea of the Installation Control Team (ICT) was formulated, and the team was convened at CFB Shearwater at 2130 hours, Monday, 13 August 1990. The ICT was composed of all the requisite design, engineering support, test and base authorities or their delegates needed to complete the task at hand.

Design Control Process

In order to provide some perspective on what was accomplished in those two weeks in August, the normal process for developing and fielding a modification would follow these steps:

a. **Statement of operational capability deficiency (SOCD)**. This document describes the operational concept and the capability which the weapon system lacks to perform the operation. In this case, the Sea King lacked the surface-surveillance and self-defence capabilities to operate as a utility support helicopter in the Persian Gulf. This document is used to obtain financial approval for the programme. The Directorate of Air Requirements (DAR) and the operational headquarters (Air Command and Maritime Air Group [MAG]) are responsible for developing and staffing the statement of operational capability deficiency.

b. **Statement of operational requirements (SOR)**. This document defines the specifications, capabilities, range, etc. which the equipment chosen to fulfill the required operational capabilities must meet. Again, DAR and the operational headquarters are responsible for developing and staffing this document. The statement of operational requirements is then used by the engineering staff to determine the appropriate equipment.

c. **Statement of work (SOW)**. This document is produced by the applicable weapon system manager (WSM) and the aircraft engineering officer (AEO) in NDHQ. The SOW defines the equipment to be installed, the technical documentation to be developed, the developmental schedule as well as test and evaluation requirements. The contracting authority issues the contract, which includes financial limitations and the SOW to the selected contractor.

d. **Preliminary design review (PDR)**. The purpose of the PDR is to provide and substantiate the details of the proposed solution to the engineering and operational staff. This takes the form of sketches showing the location of the equipment and controls, wire harness runs and notional details on the installation. Approval of the PDR authorizes the contractor to progress with the detailed design work.

e. **Critical design review (CDR)**. The purpose of the CDR is similar to the PDR, with increased scope in the area of design detail and completeness and provides a method of design verification. The technical data provided at CDR includes complete drawings, stress analysis, ground and flight test plans as well as draft operation and maintenance manuals. A design baseline is established, resulting in more rigorous documentation change control.

f. **Kit manufacture and prototype installation**. Prototype manufacture and installation commence after formal approval of the detailed design engineering package and incorporate all the customer's required changes or requirements.

g. **Physical configuration audit (PCA) / functional configuration audit (FCA)**. After the prototype is completed, two audits of the installation are conducted. The PCA is carried out by the engineering staff and compares the equipment installation against the design drawings to verify the installation is correct. The FCA is conducted by engineering and operational staff to verify the equipment operates as specified. Acceptance of the PCA/FCA enables the aircraft to enter the next phase of the process.

h. **Ground test / flight test**. Ground and flight tests are conducted against the approved test plans to verify that the systems perform to the required specifications. If required, this includes electromagnetic interference / electromagnetic compatibility (EMI/EMC) testing.

i. **Modification approval**. The final approval of the modification is granted by the completion of the Aircraft Modification Approval Form (AMAF). This form is signed by the various technical authorities and includes aircraft structures, flight dynamics, propulsion, electrical power, EMC, avionics integrity, human engineering, armament systems as well as weight and balance.

j. **Airworthiness release**. This is accomplished through the approval of the modification by the engineering, flight safety and operational authorities.

k. **Kit manufacture and fleet fit**. Once the modification is released for incorporation, the modification kits are produced, and the aircraft are modified.

l. **Integrated logistics support**. These activities include developing and issuing the operational (Aircraft Operating Instructions [AOI]) and maintenance manuals (Canadian Forces Technical Orders [CFTOs]), aircrew and technician training, maintenance programme definition, spares acquisition and tactical doctrine.

In a "normal" modification design timeline, it takes up to four months for a minor modification to go from SOW to airworthiness release and up to two years to complete a major modification. At the final count, 11 major and 10 minor modifications were designed, installed and tested during a 10-day period, with another 4 major modifications considered but, ultimately, not installed. In order achieve the goal in an efficient and safe manner, it was determined that the design control steps listed above needed to be followed. Certain liberties were taken—the SOW might simply state to "install this system" and drawings might be little more than sketches—but the design reviews, use of the modification approval form and airworthiness release were considered sacrosanct. All of the engineering subject matter experts (SMEs) required for AMAF sign-off were moved to CFB Shearwater for the duration of the exercise. Highly experienced aircrew—Major (Maj) Mike Creighton, 423 (Maritime Helicopter [MH]) Squadron, for operational review and Maj Rick Smith, Base Flight Safety Officer, for flight safety review—were delegated to sign on behalf of NDHQ. Examples of the technical and airworthiness release forms for the ALQ-144 are in Annex A.

Installation Control Team

The ICT was convened under the authority of the Director of Maritime Aircraft Engineering and Maintenance (DMAEM) and was chaired by Maj Terry Robbins, DMAEM 2-3. The ICT composition changed as the pace picked up or the task complexity changed. Including the distinct manufacture and installation support during the prototype stage and various original equipment manufacturer (OEM) field service representatives support, the team numbered more than 150. The participants were as follows:

a. NDHQ design authorities: DMAEM, Director Avionics, Simulators and Photography (DASP [Avionics]); Director Aerospace Support Engineering (DAS Eng) for structures; and Director Fighter and Trainer Engineering and Maintenance (DFTEM) for the self-defence suite;

b. Aerospace Maintenance Development Unit (AMDU) Engineering Support;

c. Aeronautical Engineering and Test Establishment (AETE) Flight Test & Clearance;

d. Defence Canada Institute of Environmental Medicine (DCIEM) chemical defence and aircrew life support equipment (ALSE) support;

e. IMP Aerospace Engineering, Technical and Material Support;

f. MAGHQ/MARCOM for liaison, requirements, production control and logistics assistance;

g. 423 (MH) Squadron as Director Maritime Air (DMA) delegate;

h. Base Flight Safety Officer (BFSO) as Directorate Flight Safety (DFS) delegate;

i. 406 (Helicopter Training [HT]) Squadron Aircrew and Technician training and AOI/CFTO development;

j. Base Air Maintenance Engineering Organization (BAMEO) maintenance authority / base ICT office of primary interest (OPI);

k. Base Technical Services Officer (BTSO) for materiel control; and

l. Base Administration Officer (BADO) for administrative support.

The primary purpose of the ICT was to provide overall control of the design, installation and test process. Also vested in this team was the authority to approve the technical and airworthiness release of the modification. Each modification was assigned to a lead engineer, who was given appropriate support in terms of assistant engineers. The lead engineers were generally the SMEs on the system being installed. Some engineering functions, such as EMI/EMC testing and flight test plan development, were provided from a centralized pool. The lead engineers were responsible for defining the engineering resources, materiel support, production interface, etc. related to the installation and for producing the associated technical data. They would bring these requirements to the ICT, who would then determine priorities, assign resources, obtain the material, allocate aircraft locations and power sources and provide any support required. In essence, the lead engineer said "I need this," and it was up to the ICT to get it, allowing the lead engineer to focus on getting the design completed. Due to the large number of systems being installed, there was a battle for location and power distribution. The ICT set up an allocation group whose sole job was to assign locations and circuit breakers. This group included operator input to ensure that the most important displays got the most visible locations. It should be noted that with the removal of the antisubmarine warfare (ASW) systems, power availability was not a problem. Also established, as a subgroup to the ICT, was a Production Control Team. This team—led by Maj Al MacDonald, on loan from MAGHQ, and Maj Mary Turkington, from BAMEO staff—was charged with managing the production resources, resolving scheduling conflicts and providing a focal point for conveying production problems to the lead engineer or the ICT. The engineers came from AMDU, AETE, DMAEM, other Director General Air Engineering and Maintenance (DGAEM) offices and IMP Aerospace.

One of the major design constraints was to keep it simple. I recall a conversation with a pilot and a navigator (both of whom had engineering degrees) on how we should develop a mechanism which could be attached to the reeling machine rails and enable the forward looking infra-red (FLIR) turret to be lowered through the sonar funnel, allowing a 360 degree (°) view. I finally ended it with a statement to the effect that this approach was feasible, but we were going to rivet a mount to the front of the helicopter and be done with it. Note that 62 hours after the ICT convened, the FLIR system test flew serviceable, and there were no complaints from the operators about it.

Another major design constraint was to use what material was available. We got a list of sheet metal, extrusions, bar stock, rivets, fasteners, connectors etc. which was in stock at CFB Shearwater and at IMP Aerospace. This was provided to the engineers with instructions to start with it. If they wanted a particular gauge of sheet metal which wasn't available, they went to the next higher thickness; it was the same with rivets and bolts—schedule trumped optimum weight. The use of "unobtainium" was severely frowned upon. Connectors were probably the item which caused the most supply issues, as they could not be easily substituted. I recall a CF188 from Bagotville making a supply run to the United States (US) for a particular connector, thus avoiding any delays by Canada Customs. To ensure the material requirements were met in a timely fashion, both CFB Shearwater and IMP Aerospace set up 24/7 supply support.

One of the biggest hurdles to be overcome was the totality of our ignorance. When the ICT convened, we had a list of only a few known systems which would be installed and a long list of possibles. Even for the systems we knew were going in, we lacked technical data—how it worked, what it weighed, what was its size, even what it looked like in some cases. The initial hours of the ICT were spent in setting up the procedures to be followed and getting some notional design work completed. The arrival of the SMEs and the actual equipment, beginning on Tuesday and continuing into Wednesday, alleviated that issue. One procedural decision was that the Department of National Defence's (DND) Round Trip Memorandum (RTM) was to be used to record the issue, receipt, completion and audit of orders. With so many decisions having to be made and directions given in short order, this system proved invaluable.

During the modification production and installation phase, there were an additional 100 plus Workshop and Modification Team personnel assigned in direct support, plus a number of people assigned to indirect activities (e.g., chase aircraft support, CFTO/AOI, checklist preparation, training assistance, etc.). The base personnel were augmented with technicians brought in from IMP Aerospace and, to a much lesser extent, AMDU. As well as setting up the production control system described above, other initiatives included moving the IMP Aerospace wire-marking machine to CFB Shearwater. To the extent possible, the prototype manufacturing was done at the base, while the production kits, which had higher quantities of the same items and lent themselves to mass production, were manufactured at IMP Aerospace.

The AMDU produced an Op FRICTION maintenance support plan and carried out an Inspection Card Deck Rationalization and produced the new deck for issue before deployment.

The cost was covered by using the existing production, engineering and goods procurement contracts with IMP Aerospace. These were topped up (sort of) later. The military units involved used their own financial resources.

Op FRICTION Aircraft Modifications

There is another whole chapter to be told on how the systems which were installed were selected, but the short story is that the Air Force was nowhere near as ready as the Navy was to install the systems needed for operations in a surface-surveillance role. The Navy had the Phalanx close-in weapons system and Harpoon surface-to-surface missile system from the CPF programme available, and they had several days' head start, as communications issues resulted in the Air Force not being advised that the operation was anything more than a planning exercise. The DMA performed the threat analysis and determined what was needed in the way of defensive suite, communications and sensors. They then went looking to see what was readily available to fill the need. Trade-offs between capability and availability were made as necessary. This process took several days and resulted in the ICT being informed on systems to install on a piecemeal basis; it was probably Thursday before the final configuration was fully defined. As noted above, Maj Mike Creighton was the DMA on-site representative and advised the engineering group on the priority of the systems. Once the operations planners in DAR got going, equipment started to appear on the install list and the design effort got underway. One of the early decisions was that six helicopters would be modified—five would be deployed and the sixth would be used for tactical development and testing. It would also act as a backup for deployment—only an unmitigated optimist would expect that on deployment day five Sea Kings would all be serviceable and would start.

Eleven major modifications were installed and the fuel-dump line was repositioned on the Sea King as follows:

a. **FLIR 2000G**. The FLIR 2000 is a commercial product manufactured by FLIR Industries, Oregon, that is used by law-enforcement agencies. It lacked some of the capabilities of a military FLIR, but didn't have the three-month lead time to acquire. The first unit arrived on Wednesday, 15 August, and the prototype flew on Thursday.

b. **AN/APR-39 Radar Warning Receiver (RWR)**. The RWR system is manufactured by Northrup Grumman, but these units were borrowed from 10 Tactical Air Group (10 TAG) stock. The sensors were mounted on either side of the nose and the tail of the helicopter. There were no technical problems caused by this system.

c. **M130 Flair Dispenser**. The system is manufactured by Tracor, but the units used were borrowed from 10 TAG. The dispenser holds 30 chaff or flare munitions but cannot carry them simultaneously. The empty weight of the dispenser is 28 pounds (lb, 12.7 kilograms [kg]). The full weight is 41 lb (18.6 kg). The dispenser was mounted just aft of the cargo door.

d. **AN/ALE-37 Flare and Chaff Dispenser Pod**. MAGHQ staff used their contacts and managed to borrow these units from the United States Navy (USN). A CP140 Aurora from CFB Greenwood flew to Naval Air Station Jacksonville, Florida, to pick up the unit used for the prototype installation. This dispenser can hold a combination of 240 chaff and flare munitions. Its empty weight is 180 lb (81.6 kg) and full weight is 277 lb (125.6 kg). These were mounted on the left-hand aft hard point. The AN/ALE-37 is a much more flexible and capable dispenser than the M130; however, the AN/ALE-37 was a late addition to the self-defence suite—the M130 installation had already been prototyped by the time the AN/ALE-37 was added to the equipment list. Two AN/ALE-37s would have been preferable to the AN/ALE-37 / M130 mix, but the aft location and weight of the AN/ALE-37 precluded carrying two.

e. **AN/ALQ-144 (V) Infrared Counter Measures**. The system is manufactured by Sanders Associates, but the units used were borrowed from 10 TAG. MAGHQ again used their contacts to determine how the United States Marine Corps mounted the AN/ALQ-144 on the US Presidential VH-3, but they were not forthcoming with much assistance. A decision was made to mount the unit on the underside of the tail cone. Sanders sent a technical representative to set them up for this mounting orientation. This system caused the most integration problems (more on this later.)

f. **Repositioned fuel-dump line**. During testing of the AN/ALQ-144, it was noted that during a fuel dump operation the resulting cloud of fuel came in contact with the unit. There was great concern that the heat of the unit would ignite the fuel. (The test was done using a cold system.) The AETE recommended solution was to either move the AN/ALQ-144 or change the fuel dump system. As moving the AN/ALQ-144 was out of the question (this problem was discovered at 1500 hours, 18 August, halfway to the departure date!), the approach taken was to lengthen the fuel dump line and point it further downward. A subsequent test flight, conducted at 1800 hours the same day, confirmed a successful solution.

g. **Trimpack Global Position System (GPS)**. The Trimpack, manufactured by Trimble Nav Limited., is a "C" mode GPS unit aimed at commercial and law-enforcement aviation. It is not as capable as a military GPS, but once again, it was available in time to meet the need. The unit is battery powered and came without a power supply. This was rectified in-theatre. There was some concern that the placement of the antenna part-way down the tail cone would result in masking by the main rotor blade pass. This location was defined by the length of cable provided with the units—there was a four-week lead time for a longer one. During testing, it was found that the antenna picked up and held lock on more than the minimum required number of satellites.

h. **C9 light machine gun**. The preferred gun was the 7.62 millimetre C6, but the Navy stated that they would only be carrying 5.56 ammunition. The gun was mounted to the rear frame of the cargo door. A bag to catch spent rounds and links was added, as initial testing showed them to be exiting the aircraft and providing a potential foreign-object-damage (FOD) hazard. Testing was carried out by taping a video camera to the gun and checking the arc through various aircraft manoeuvres. The initial stops were adjusted to keep the gunfire away from the sponson and the main rotor arc. The gun was bolted into the mount. There was some discussion of installing it with a quick release pin so that it could be removed from the mount and hand-held for firing out the passenger door. This operational concept was declined.

i. **Laser warning receiver**. A SLIPAR Industries laser warning receiver was mounted on the instrument panel glare shield to advise the crew if they were being painted by a laser designator. In conjunction with this, the crew helmet visors were replaced with a unit which would automatically darken if excited by a laser beam, providing eye protection.

j. **AN/APS-503 radar cooling fan**. Technician experience with the AN/APS-503 radar receiver was that it was unreliable in hot weather. To alleviate this, a fan was mounted on the receiver and hard-wired to run when the unit was on. Feedback indicated that this solution worked.

k. **Aircrew-seat armour**. There were no readily available armoured crew seats which fit the Sea King without extensive modification to the seat rails. In the interest of time, seat pan and back inserts were custom made from SPECTRA Shield (a proprietary material based on Kevlar). The weight of the material precluded adding sheets to the floor in the passenger area.

l. **Aircrew cooling vest**. The operators voiced concern that the high ambient temperature of the Persian Gulf area would result in crew fatigue which could lead to safety issues. The installation of the air conditioning unit from the USN VH-3 would have required extensive modification of the starboard sponson. There were no commercially available units which could be easily fitted either. A National Association for Stock Car Racing

(NASCAR) fan suggested using the driver cooling vest in use at the time. This consisted of a vest with tubes through which water was circulated by a small pump. The water was cooled by passing it through a cooler filled with ice. This turned out to be a simple, but effective, solution.

The external location of these modifications on the CH124A are shown in Figure 1.

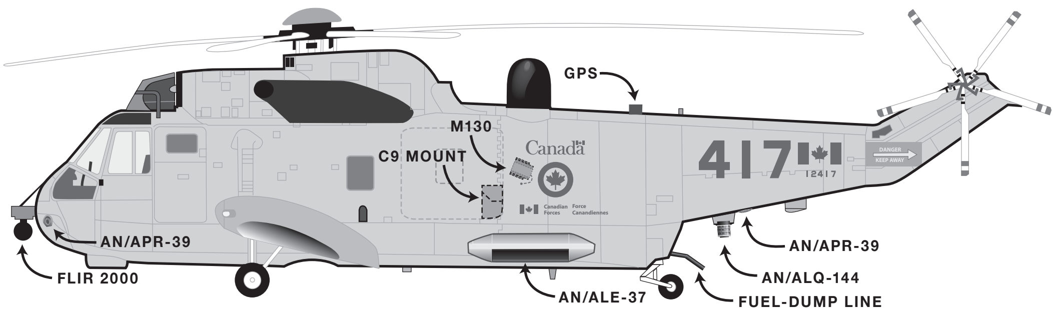

Figure 1. Modified CH124A for Operation FRICTION

The following modifications were considered but not achieved due to time, procurement or testing constraints:

a. **AN/AAR-47 Missile Approach Warning System** (MAWS) manufactured by Loral (now part of BAE Limited). These units arrived late. They were trialed, but we couldn't get the antenna placement correct in the short time available. The test-and-evaluation aircraft was used post-deployment to determine the proper antenna location. The system was fitted later, but not in time for use in Operation FRICTION.

b. **KY-75 high frequency (HF) secure voice**, to complement the KY-58 very high frequency (VHF) secure voice installed in the aircraft, was contemplated but was not available in time for inclusion.

c. **AN/ARC-164 HAVE QUICK**. The AN/ARC-164 ultra-high frequency (UHF) radio was already installed in the Sea Kings. The addition of a HAVE QUICK microprocessor would have enabled it to operate in a frequency-hopping mode as an anti-jamming functionality. The required components were not available in the required time frame.

d. **AUTOCAT UHF relay system**. This system, which is used to extend the range of UHF communications, was not available in the required time frame.

The following minor aircrew life support equipment and safety systems modifications were carried out concurrent to the aircraft modification activity: AC-4 Chemical Defence Suite, emergency breathing system, ANVIS night vision goggles (only for the observer), helmet communications modification, desalinization and desert survival kits were added to the back-pack, and miscellaneous stowage modifications as well as protective covers and shields.

Technical Problems

All the technical problems which were encountered, with the exception of the fuel dump problem described above, arose from EMI/EMC issues with the systems. The systems were all designed for aviation use and had flown on different aircraft, but never all together and not on a Sea King. The EMI/EMC testing was done by a flight test engineer from AETE, assisted by an EMI/EMC engineer from IMP Aerospace. The individual systems were checked as part of the prototype installation testing, but there were only two days in which to test all the systems against each other and against those of the ship.

The AN/ARN-504 tactical air navigation (TACAN) equipment caused black streaks on the FLIR 2000 monitor. Operational evaluation was that this interference did not affect the usefulness of the FLIR and was, therefore, acceptable.

The AN/ALQ-144 caused the AN/APN-171 radar altimeter (RADALT) indicator to oscillate during the first 20 seconds after turn-on. This problem did not occur in flight and was considered to be of nuisance value.

During the power-up sequence of the FLIR, a low-grade interference was heard in the intercommunication system (ICS). This did not cause a problem when the aircraft was on engine power or flying because of the high-ambient-noise environment.

When the AN/APS-503 search radar was transmitting, the AN/APR-39 RWR was not useable in "Discriminator Off" mode due to multiple strobes on the display. The AN/APR-39 display was clear of strobes when selected to "Discriminator On" mode. There was a loss of sensitivity associated with operating in "Discriminator On" mode; however, this was deemed acceptable. The EMI problem was not solved, and an operational restriction was imposed, requiring the operation of the AN/APR-39 in "Discriminator On" mode when the AN/APS-503 was transmitting.

The AN/ALQ-144 caused the Bearing Distance and Heading Indicator (BDHI) compass rose to change heading up to 143° when the Gyro Heading and Reference System (GHARS) was in magnetic (MAG) mode and either manual or auto align was selected. This meant that when the GHARS magnetic mode was used, the variation would be updated incorrectly and, therefore, the directional references for all the navigation aids (NAVAIDS) would be incorrect. Operation in the directional gyro mode without the ability to update/check the correct heading was considered a flight safety risk due to gyro drift. The EMI problem was not solved, and an operational restriction was imposed, requiring the operation of the GHARS in "FREE/DG" mode during operation of the AN/ALQ-144 and that GHARS 30-minute checks were to be carried out using radar fixing / GPS to validate the gyro heading.

The Standby Compass heading deflected up to 40° when the AN/ALQ-144 system was operating: this was deemed too significant an error to ignore. At this time, the Pacific Engineering Test Establishment was working on the compensation algorithms for the Magnetic Anomaly Detector (MAD). The issue they were addressing was that the tail boom flexed in flight and caused the Magnetic Anomaly Detector readings to fluctuate. They had done a magnetic survey of the tail boom, so we asked them where the quietest point was. The flux valve was relocated to that point, and the compass deflection dropped—to 34°. Lieutenant-Commander (LCdr) Rick Dickenson, on exchange from the Royal Navy (RN), a crew of technicians and two Base Maintenance Test Flight (BMTF) pilots took the spare aircraft (the fleet had sailed by now) and spent several hours doing compass swings. They unclipped the flux valve wire harness, nested the flux valve in Styrofoam and moved the unit around until they found a location which dropped the deflection to 12.5°. This was acceptable to the operators, so modification kits were manufactured and sent to meet the fleet in Gibraltar.

Sequence of Events and Milestones

The "key" events and milestones are listed in Tables 1 and 2 and summarized in Figure 2. It is impossible to recreate the pace of decision making or critical path "adjustments" which characterized the momentum of the moment. The fuel-dump line repositioning described above, however, is a good example of the speed with which problems had to be resolved.

Date	Event
Fri 10 Aug to Mon 13 Aug	Start-up and planning
Mon 13 Aug to Mon 20 Aug	Augment design and prototype
Thu 16 Aug to Wed 22 Aug	AETE test flying
Sat 18 Aug to Wed 22 Aug	Production and installation
Tue 21 Aug to Fri 24 Aug	EMI compass swings aircraft weighing ship trials
Fri 24 Aug	Aircraft deploy
Sat 25 Aug to Fri 14 Sep	Helicopter Operation Test and Evaluation Flight (HOTEF) AA Priority Demonstration and Evaluation (DEVAL) Supported by: AETE and Defence Research Establishments at: Valcartier (DREV), Ottawa (DREO) and Victoria (DREP)

Table 1. Broad scale of events (with concurrent activity)

Date / Time	Milestone	Time After ICT Convenes (hrs)
13 Aug 2130 hrs	ICT convenes	0
16 Aug 1200 hrs	FLIR test flown “S” (serviceable)	62.5
21 Aug 1700 hrs	First aircraft delivered to squadron	187.5
23 Aug 1800 hrs	Ready in all respects (5 aircraft delivered)	236.5
24 Aug 1330 hrs	Aircraft deploy	256
24 Aug	1. DEVAL A924L-90 assigned to HOTEF (14 tests) 2. Tactical doctrine development commences	-
3 Sep	Test plan issued	-
13 Sep	Interim report issued (37-page message)	-

Table 2. Key milestones

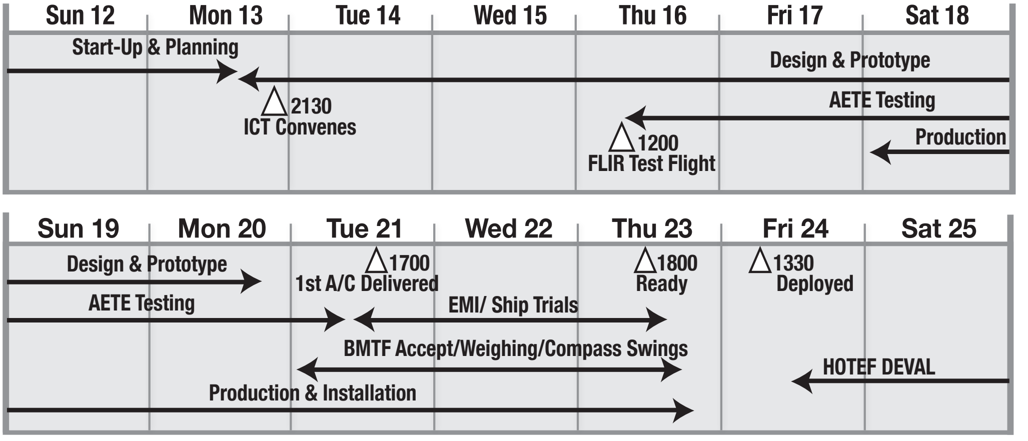

Figure 2. Op FRICTION milestones, August 1990

Non-ICT Activities

While the paper is principally oriented to the ICT activities, there were many other things happening at the same time which were equally important to the operation as a whole. 423 (MH) Squadron was intensely involved, of course, in the many training, readiness, administration and personnel preparations for an operation of this magnitude. The various base and 406 (HT) Squadron sections assisted in these preparations. Some of the activities were:

a. aircrew and groundcrew training;

b. personnel screening and augmentee selection;

c. personal administration (passports, immunization, etc.);

d. briefings (theatre, weather, etc.);

e. dependent support preparation and briefings;

f. kit issue;

g. special preparations (chemical agent monitoring, mode IV identification friend or foe [IFF], flight pubs, maps, etc.);

h. ship liaison and preparations; and

i. weapon practice.

As well as the direct ICT aircraft activity, BAMEO also provided the following support:

a. ASW deconfiguration;

b. aircraft log record review and selection of aircraft;

c. major component quick change unit (QCU) preparations;

d. supply account review and augmentation;

e. Avionics Support Organization (AVSO) laboratory immediate operational requirement (IOR) satisfaction;

f. transient servicing;

g. support to increased 32 (Utility) Squadron flying; and

h. dangerous-cargo handling.

The Base Administration and Base Technical Services branches provided support to all of the above activities plus other activities such as:

a. airhead support for Navy;

b. food service support for 24/7 operation;

c. significant local purchase order (LPO) and IOR; and

d. family support (financial counselling, wills, power of attorney, etc.).

HOTEF developed tactics and operational procedures.

Facts and Figures

Some significant or interesting facts and figures are as follows:

a. 4,000 man-hours of workshop activity;

b. 900 man-hours of refinishing activity;

c. 2,000 man-hours of safety systems activity;

d. 7,800 photo prints produced;

e. 60 hours of video produced;

f. 230 passport photos produced;

g. 600 IOR demands processed;

h. 300 regular priority Op FRICTION demands processed;

i. 400 local-purchase-order demands processed (>$200K);

j. 1,500 box lunches prepared;

k. 370,000 lb [167,829 kg] of ammunition handled;

l. 33,000 lb [14,969 kg] of general cargo handled;

m. AETE flew 15 test flights for 31 hours;

n. BMTF flew 7 acceptance flights for 23 hours and conducted 15 compass swings for 43 hours;

o. transient servicing handled 62 special flights;

p. 32 (Utility) Squadron flew 94 T-33 hrs in direct support; and

q. NO flight safety or general safety incidents occurred.

Lessons Learned

The following major lessons were learned:

a. **By the book**. The most efficient and effective way of doing anything in a hurry is by the book that you know (i.e., familiar and proven procedures).

b. **Discipline**. The faster the pace, the greater the momentum, the more worrisome the problem or the deadline, the more critical it became to enforce, encourage and increase the disciplines of technical leadership at every level. The faster you go, the less you can cut corners and the more you have to challenge, verify, repeat back and think twice. It is always, always better to do it right the first time and only once.

c. **Written orders**. The DND Round Trip Memorandum was used to enormous effect to record the issue, receipt, completion and audit of orders when the pace was frenetic. It is also mandatory that journals, diaries and other unit action logs be kept. Watch out for ad hoc meetings where decisions are taken without record.

d. **Workshop trades vital**. The workshop trades personnel are vital to any aircraft mobilization. While contractor support contributed significantly, it was the uniformed workshop tradesmen who provided the leadership, discipline, drive and, in many cases, the innovation critical to the success of the operation.

e. **Critical military specialist skills**. The military cannot afford to be without the critical flight test, stores clearance, EMI, systems integrations and operational test and evaluation (OT&E) skills necessary to a mobilization effort as was Op FRICTION.

f. **Baseline testing**. The Sea King did not have the baseline testing so necessary for modern mission suite installation and integration such as infrared signature, radar cross section, magnetic signature, EMI baseline and aircraft power survey.

g. **Quality assurance (QA) configuration control**. Always critical, it is imperative to increase vigilance in these areas during any fast-paced modification effort. With the number of systems being installed, all looking for space and power, control of the real estate was a critical factor.

h. **Delegation**. Virtually all of the detailed decision making and action taken was done at the major and below levels (as it should). Lieutenant-colonels and above were there to establish the delegations, to "enable" the team, to resolve and expedite resource issues and to prepare for the next step.

i. **Luck was a significant factor**. Weather was good; there was no diversion of effort on another aircraft at the same time; nothing significant went wrong!

Conclusions

The preparation effort for Op FRICTION was a tremendously challenging, intensive and rewarding experience. Our success was due to so many interactive factors that it would be impossible even in hindsight to identify the magic elements. We had a clear mandate, with the resources to meet it, and we formed a highly effective team framework with strong leadership at every level. The lessons learned were invaluable and timeless. They are generally repeatable—the processes and procedures followed by the ICT were commonly used across the Air Force and were not specific to the Sea King or to the particular operation. Op FRICTION was a once-in-a-lifetime experience for those who were involved but generally proved that the Sea King community was capable of performing extraordinary feats when called upon to do so.

Annex A – AN/ALQ-144 Technical and Airworthiness Release Forms

ALQ-144 Technical Release (AMAF)

Technical Review ALQ-144

Item	(1) Reviewer Designation	No (2) Effect	Status (3) OK	See (4) Attach	Reviewer Signature
Aircraft Structures	Capt McRae		✓		
Flight Dynamics	Mr N. Crawley		✓		
Propulsion	N/A				
Electrical Power	WO Ferguson		✓		
EMC	Capt Smith				
Avionics Integrity	Capt Chiasson		✓		
TEMPEST Air	N/A				
Human Engineering	N/A				
Stores Certification	Capt Godwin		✓		
Armament Systems	N/A				
Photo/Imagery	N/A				
Standardization/Interop.	N/A				
Aircraft Airconditioning	N/A				
Weight Balance	Maj Robbins		✓		
BAMEO Rep	LCdr Dickenson/ Capt Turkington			✓	

<u>WEIGHT AND BALANCE DATA</u>

Weight
71.0 lbs

Moment
31.3

<u>AIRCRAFT AFFECTED</u>

CH124, 407, 410, 412, 413, and 426.

ALQ-144 Airworthiness Release

Airworthiness Review

Aircraft Types:

Robbins	Maj			
Name	Rank	Designation WSM Sect Head	Signature	Date

Aircraft Types:

Name	Rank	Designation WSM Sect Head	Signature	Date

Aircraft Types:

Name	Rank	Designation WSM Sect Head	Signature	Date

Operational Review

Aircraft Types:

Creighton	Maj			
Name	Rank	Designation WSM Sect Head	Signature	Date

Aircraft Types:

Name	Rank	Designation WSM Sect Head	Signature	Date

Aircraft Types:

Name	Rank	Designation WSM Sect Head	Signature	Date

Flight Safety Review

R. Smith	Maj			
Name	Rank	Designation WSM Sect Head	Signature	Date

DFS 286 151200Z ADG 90

ALQ-144 Flight Test #4 Summary

FLIGHT TEST SUMMARY

System: ALQ-144	Test Flight #4	Date 18 Aug 90
a/c#: 404	Flight Time 1.2 hrs	Time 1500 hrs

Objective:

To determine the separation between the ALQ-144 IR Jammer and the fuel cloud when dumping fuel from the CH124 helicopter.

Method:

With the IR Jammer turned off, fuel dump was initiated at 70 and 50 knots in steady level flight.

Results:

At 70 knots, a portion of the fuel cloud hoist was hitting the ALQ-144 IR Jammer. At 50 knots, the fuel cloud was clear of the Jammer due to the effect of the rotor downwash.

Recommendation:

Based on the inadequate clearance between the fuel cloud and the IR Jammer which could result in a catastrophic explosion, it is recommended that the location of the IR Jammer and/or the fuel dump be changed such that adequate clearance be maintained in all modes of flight.

C. Mendrisky
Maj
AETE DET CO
1814

DISTRIBUTION LIST

B Comd
ICT Leader (LCol Grant)
BAMEO
OIC HOTEF
CO AETE (by FAX)

ALQ-144 Flight Test #5 Summary

FLIGHT TEST SUMMARY

System:	ALQ-144	Test Flight #5	Date 18 Aug 90
a/c#:	413	Flight Time 1.2 hrs	Time 1800 hrs

Objective:

To determine the separation between the ALQ-144 IR Jammer and the fuel cloud when dumping fuel from the CH124 helicopter with the modified fuel dump system and to determine any operational restrictions that this system may impose.

Method:

With the IR Jammer turned off, fuel dump was initiated at 70 and 90 knots in steady level flight, and for left and right sideships up to 20°. Finally fuel was dumped during an autorotation at 70 knots, 2,200 ft/min descent.

Results:

For all test conditions, the fuel cloud remained well clear of the IR Jammer, as observed during the flight, and after review of the chase video. The position of the modified fuel dump tube may potentially cause interference with the tail guide winch cables during straightening on the deck of the steamer and 280 classes of ships.

Recommendations:

Based on the results of this and the previous test flights, it is recommended that:

a. the ALQ-144 IR Jammer system be retrofitted into the remaining OP FRICTION a/c as per the prototype installation on the condition that the present modification to the fuel dump system is also incorporated;

b. the M-130 system be cleared for safe carriage for OP FRICTION a/c up to 0.9 VNE;

c. the M-130 system be flight tested again as part of integrated systems testing on a fully modified a/c; and

d. further testing should be carried out to determine if the tail guide winch cables would interfere with the fuel dump during straightening.

…/2

Terry Robbins

Terry Robbins has 35 years' experience in the management of aircraft and weapon systems engineering, including design, modification, testing as well as repair and overhaul. Of that, 24 years has been in direct association with the Sea King helicopter in both military and civilian functions.

Terry began his career at 12 Wing Shearwater, serving as a first line Sea King maintenance officer at 423 Maritime Helicopter Squadron that included an operational deployment aboard Her Majesty's Canadian Ship (HMCS) PRESERVER. This was followed by a staff position in National Defence Headquarters (NDHQ), a technical services detachment quality assurance role at IMP Aerospace and a second posting as the Air Maintenance Officer in HMCS PRESERVER. It was then back to NDHQ where he broadened his experience in project management and engineering support as the Sea King Aircraft Engineering Officer. His efforts there were rewarded with a most enjoyable tour as the H 3 Project Officer on exchange with the United States Navy at the Naval Aviation Depot (NADEP) in Pensacola, Florida. His last military posting was as Systems Engineering Manager for the Maritime Helicopter Program.

His first civilian job was with SPAR Aviation Services, where he supported the repair and overhaul of dynamic components for the Sea King fleets of the Canadian Forces, United States Navy, Brazilian Navy and Royal Malaysian Air Force. This was followed by a move to IMP Aerospace in Halifax, where he established the maintenance programme for the Cormorant search and rescue helicopter. He then spent several years as the Engineering Manager for the rotary-wing programmes, providing engineering services in support of the Sea King and Cormorant. He is currently employed as a proposal manager.

Terry has a degree in Mechanical Engineering from the University of New Brunswick. During his military career he received the Chief of the Defence Staff Commendation for his leadership in preparing the Sea Kings for Operation FRICTION and the Secretary of the United States Navy Commendation for his work at Naval Aviation Depot, Pensacola.

Chapter 8

Depot-Level Support to the CH124 Sea King

Terry Robbins

Introduction

That the Sikorsky CH124 Sea King has met the milestone of 50 years of service in the Canadian Forces (CF) is not happenstance. Decisions were made by the uniformed engineers in Ottawa in the 1970s and 1980s that have paid off in a way that can only be measured by the fact that the Sea King remains in airworthy operation in the year 2013. Those forward thinkers were the senior Aeronautical Engineering (AERE) officers who resided in the Director General, Aircraft Engineering and Maintenance (DGAEM) organization, the direct IMP Aerospace engineering customer. Their foresight and contributions to the maritime fleets of aircraft must be acknowledged, especially so on the CH124 Sea King, which went into a depot-support programme at IMP Aerospace and benefitted from the work started by Director, Maritime Aircraft Engineering and Maintenance (DMAEM) staffs. One can point to sustained initiatives during the 1975–1985 era in which the Department of National Defence (DND), working hand-in-hand with the engineering community at IMP Aerospace, created the nucleus of an engineering-support capability within IMP Aerospace that readied the company to accept engineering cognizance, and the production work that followed, for the CH124 in the mid-1980s.

IMP Aerospace

IMP Aerospace has been involved with domestic and international Sea King repair and overhaul, parts/components manufacture, engineering, publications and logistics support for 30 years. IMP Aerospace is a full-service aerospace company, with Aerospace, Avionics and Aerostructures divisions. IMP Aerospace has over 1,500 employees, providing engineering, technical, materiel and support expertise. It has an ISO 9001-registered quality system and holds Accredited Maintenance Organization and Accredited Technical Organization approval from both the CF and Transport Canada. IMP Aerospace provides complete life-cycle support services, including engineering, integrated logistics, publications management and asset management. IMP Aerospace is a Sikorsky authorized service centre for the manufacture of S-61 sheet-metal parts and is the Hamilton Sundstrand world-wide licensee for the repair of the Sea King automatic stabilization equipment. IMP Aerospace has developed a broad range of expertise in support of aging aircraft.

IMP Aerospace became involved with the depot-level support to the Sea King as part of the Repatriation of Sea King Depot Level Support (ROSKDLS) programme. The Sea King Replacement Program Office was established in 1978; its intent was to field a replacement aircraft within a reasonable time frame. In 1980, Pratt and Whitney Canada, a sister division of Sikorsky Aircraft Corporation and the provider of depot-level support to the helicopter, determined there was no future in Sea King support. They were also developing the PT-6 engine at the time, which was drawing manpower and resources away from the helicopter programme. DND then went looking for a new service provider who would also be acceptable to Sikorsky; Sikorsky refused to allow the Sea King technical data package to fall into the hands of their competitors, so a non-aligned aerospace company was required. In 1982, IMP Aerospace became the engineering and depot-level maintenance contractor for the Sea King, while SPAR Aerospace became the dynamic component overhaul contractor. DND bought the technical data and drawings and entered into a technical assistance agreement with Sikorsky for data updates and engineering assistance. IMP Aerospace became the engineering-cognizance contractor and holds the technical data set. They also established a depot-level capability for the aircraft and selected components. IMP Aerospace Production staff doubled in size—there was no lack of retired military personnel who were Sea King trained and willing to stay in the Halifax area. IMP Aerospace Engineering staff increased by 50 per cent. These individuals had to be recruited and trained.

The Value of an Overhaul Contractor

Those who have not been associated with depot-level support to military fleets of aircraft like the Sea King do not always recognize the roles played by those agencies, but they can be readily identified. They form the framework behind the argument that selecting and staying with one overhaul contractor is the most effective means of obtaining long life from an aircraft: squadrons move; operating bases change; military personnel move through their system; governments change; government departments evolve; maintenance resources at operating bases (both human and otherwise) rise and fall irrespective of operational needs; maintenance practices change; original aircraft manufactures develop new products and, for economic reasons, drop support to their older aircraft; technology changes; and operational roles of aircraft change and, hence, the aircraft themselves change. In all, the environment in which fixed- and rotary-wing aircraft operate is in constant flux, and the effects are disruption and loss of control. The results can be seen in the compromise of a country's military capability: in-service fixed- and rotary-wing aircraft that cannot be supported sit on the ground. Therefore, the most important role of depot-level contractors is this: they provide the knowledge base and the continuity which otherwise would be lost in this sea of constant change.

In-service but out-of-production aircraft quickly become logistics nightmares. However, IMP Aerospace had cut its materiel teeth for ultimately supporting the Sea King on their work on both the CP107 Argus and CP121 Tracker fleets during the 10 or so years prior to assuming the long-term depot-level support of the CH124. Approved sources of qualified parts, awareness of the pitfalls of bogus parts, integration with the Canadian Forces Supply Systems and engineering methods for qualifying alternative parts or designing around the problem had been established well in advance of the challenges of supporting the Sea King. As anyone in the industrial or government materiel world will attest, out-of-production and long-in-the-tooth aircraft present challenges, as the acquisition of replacement parts can bring grown men to tears, usually because of the cost of work-arounds. "Work-around" often means engineering redesign, and redesign in the aerospace industry does not come cheaply. If anyone in the aircraft support world deserves recognition, logisticians should be close to the top of the list. Similarly, production workforces in a depot facility will, without much encouragement, patiently explain why their jobs on the hangar floor are not exactly a walk in the park. They and their supporting departments are all unsung heroes.

Unsupported technical documentation can be a serious problem, bordering on a flight-safety issue. Intermittent attention to this most fundamental requirement—and/or the moving of the responsibility around from agency to agency—is horribly disruptive and terribly expensive. The solution rests with the overhaul contractor. Well aware of this from their Tracker experience and observing the need for rescue of the Sea King technical documentation set, two initiatives came from IMP Aerospace in that regard, both of them aimed at cleaning up a serious problem with Sea King documentation.

The master drawing set for the CH124 when IMP Aerospace inherited support of the fleet was, in a word, unusable. Through no fault of anyone in particular (the Sea King was going out of service, right?), the only official documentation for the aircraft consisted of original drawings from previous companies upon which had been stacked change data in such quantities over such a prolonged period of time and in such a convoluted manner that the effort consumed in making engineering decisions was huge and the risk of error great, particularly when dealing with aircraft structures and electrics/avionics. There were change notes on top of change notes on top of prior change notes that, for those with patience, would ultimately track to the original drawings. That led to IMP Aerospace taking over the CH124 master drawing set and incorporating collections of accumulated changes. That was a major programme, chipped away at with DND support over a period of years. In many, many cases, it involved the recreation of the original data by new drawings with the changes incorporated and the drawing change history retired to the archives.

As it was for the Sea King master drawing set, so it was for the CH124 Canadian Forces Technical Orders (CFTO): they were of dubious integrity. Even Maintenance Instructions for the Canadian Navy (MICNs), for those who remember those documents, were necessary to support the helicopter in the field. That situation came to a head during the rewiring of the fleet—neither the aircraft drawing set nor the CFTO wiring diagrams bore much resemblance to the real world. The longer-term net result of this situation was the assumption by IMP Aerospace of responsibility for the creation and upkeep of CH124 technical publications set—including the *Aircraft Operating Instructions*—and significant growth in the rudimentary capability that had been developed for support of the CP121 CFTOs. IMP Aerospace produced, and continues to produce, CH124 CFTOs.

Engineering Support

The other benefit a depot-level support organization provides is that of a stable, long-term engineering organization—the lead effort for depot-level support starts in the engineering community. At IMP Aerospace, that engineering work began with the CP121, primarily as the result of the very successful Tracker Surveillance Update Program, a huge and challenging undertaking by all concerned at that early point in IMP Aerospace's time, since it involved the prototyping of some systems that had yet to see any previous airborne application. That is where IMP Aerospace learned its systems-integration skills and developed (however rudimentary, then) the methods and processes associated with support of aircraft avionics and electrical systems that continue to this day. The core engineering concept was subsequently expanded to embrace the CP107 Argus, then nearing the end of its useful life, yet from a structural perspective, it was still expected to fly safely. Introduction of the CP140 Aurora represented an incremental improvement in the development of core engineering skills within IMP Aerospace, again supported fully by the engineering community in Ottawa. Even before the first CP140 aircraft delivery, IMP Aerospace engineering was heavily involved in the induction process, working hand-in-hand (and on site) with Lockheed. This provided a firm foundation for the formal introduction of the Aurora to the plant. Thus, when the opportunity presented itself to introduce the new rotary-wing programme into IMP Aerospace, the engineering transition was more-or-less seamless. It was a matter of cloning known effective methods and processes, and organizations, along with supplementing the formal management procedures and updating Approvals and Quality Program documentation. ISO 9001 approval was subsequently obtained on the basis of them. Furthermore, although IMP Aerospace was still being exercised on a task-by-task basis, the company had already successfully undertaken a broad range of engineering projects and subsequent production work for the CH124 helicopter: the records show that 39 projects were on the books before the first hint can be found (in 1982) of the formal move of in-service depot-level support of the helicopter to IMP Aerospace. By the time that IMP Aerospace was awarded the responsibility for providing depot-level support to the Sea King, all the engineering and other skills were already in place, and the company was ready. Thereafter, the size and composition of the skill set within engineering has grown in direct proportion to the needs of the helicopter.

Depot-Level Support and Modifications

In 1963, the Royal Canadian Navy started taking delivery of 41 Sikorsky Aircraft Corporation Sea King helicopters for antisubmarine warfare (ASW) operations. As of this writing, there have been 813 field-level modifications and 498 contractor-depot modifications developed and incorporated into the aircraft. These modifications range from simple part substitutions to equipment/system upgrades to three complete role changes. This paper will not discuss all the modifications, only those contractor-level modifications which had a significant operational impact or improved the structural strength of the aircraft. The first modification occurred in 1965 when the auxiliary flotation bags were added.

During 1965 to 1967, equipment improvements included removing the AN/ASA-13 navigation system and installing the AN/APN-503(V) Marconi Doppler navigation system, installing the 618T-2 high frequency (HF) radio system, replacing the AN/ARN-52(V) with the AN/ARN-501 (V) TACAN (tactical air navigation) system, retrofitting the AN/AQS-10 with the AN/AQS-13 sonar for improved ASW capability, and structurally reinforcing internal bulkheads where cracks had been found (more on this later).

During 1969 to 1970, equipment improvements included installing the AN/ASN-501 tactical navigation computer; installing the engine foreign object damage (FOD) deflector (referred to as the FOD mod) to improve engine reliability; and strengthening various areas on the airframe, including the tail probe attachment, main transmission support structure, the upper left-hand tail cone hinge and a bulkhead. The lower personnel door latching system was improved to prevent accidentally opening the door. This resulted from an incident where a passenger fell from a helicopter in flight. The interim solution to the problem, which remains to this day, was the "Barker Bar," named in honour of the man who fell from the aircraft and was safely returned when he was discovered clinging to the sponson.

The year 1975 saw the beginning of the Sea King Improvement Program. This program included upgrading the General Electric T58-8B to the T58-8F engine (generating 1,350 shaft horsepower [1,006.7 kilowatts at the rotor head] and increasing the all-up weight (AUW) to 20,500 pounds [9,298.6 kilograms]) and installing main and tail rotor de-icing (subsequently removed), a low rotor revolution per minute (RRPM) warning system, the AN/APS-503 radar and the AN/APQ-501 Radar Altimeter Warning System (RAWS). Structural improvements included installing a steel upper tail cone hinge fitting, beefing-up the sponson stub wing, reinforcing the sponson main landing gear structure, reinforcing internal bulkheads and installing stronger landing gear drag links to withstand destroyer deck landings, as a result of a crash on the deck.

During 1977 to 1979, the Sea King Omnibus Modification Program began. This included the change from a forward-facing seating arrangement for the navigator and sensor operator and installing the sideways-facing console. This was intended to aid in crew coordination and safety. The programme also encompassed the installation of the AN/AQS-502 dipping sonar, Bathythermograph and On-top Position Indicator to improve the ASW capabilities. The AN/APX-77 Radar Identification System was installed to provide a crypto-secure radar identification capability. Chutes for internal stores carriage were installed—no more throwing smoke markers or signal-underwater sound (SUS) charges out the window! Structural changes included improvements to the tail-wheel support assembly to prevent cracking and installation of the In-Flight Blade Integrity System (IBIS) due to concerns with cracking of the main rotor blade spar. In this system, the spar is pressurized, and a radioactive source is uncovered if the blade pressure drops. The radiation is detected by a sensor, which gives the pilot an indication of the pressure drop. Due to the short period from crack initiation to catastrophic failure, a blade with a conventional blade inspection method has to be shut down and visually inspected every 12 hours. The IBIS allows unlimited flight time.

The next block improvement occurred from 1981 to 1984, known as the Sea King Update Program. AN/ARR-52A sonobuoy receivers were installed to provide sonobuoy receiving capability, including racks for carrying up to 18 sonobuoys. AN/ARC-511 very high frequency (VHF) amplitude modulated (AM) and AN/ARC-513 VHF frequency modulated (FM) radios were installed to provide expanded communications capability. A KY-28 secure voice system and a crash position indicator were installed; the AN/APN-171 radar altimeter replaced the AN/APN-117.

Nineteen eighty-four saw the commencement of the depot-level inspection and repair (DLIR) programme at IMP Aerospace. This was the first DLIR for the aircraft since they had been delivered to the Royal Canadian Navy. The primary purpose of the DLIR was to perform a systematic, in-depth inspection for, and repair of, corrosion. All of the aircraft systems, including the floorboards and fuel cells, were removed. At this time, the paint was changed to a low-gloss polyurethane paint. The DLIR also provided an opportunity to completely rewire the aircraft. Inspection of the wiring revealed insulation break-down, sleeving cracking and numerous splices. The many no-fault-found system problems and consequent mission losses were attributed to the condition of the wiring. The rewire used MIL-W-23795 wire and MIL-C-27500 cable (which were modern, much more robust wire specifications than originally used) and remain on the aircraft to this day. The wire harnesses were designed and installed at IMP Aerospace and were manufactured at IMP Avionics Division. When the prototype rewire Sea King was received in plant, IMP Aerospace found it necessary to design a new wire harness: this was accomplished by Production removing old harnesses, documenting the interconnection as found on the aircraft, and feeding the raw data to Engineering for use in new design. The success of this programme led to IMP Aerospace implementing a similar programme for the Egyptian Air Force Sea Kings from 2003 to 2006. DLIR also saw the replacement of most of the fuselage fittings with 7075 T-73 aluminum. The original T-6 aluminum fittings, while slightly stronger, were prone to stress corrosion cracking. Although this problem was never confirmed on the Sea Kings, good stewardship demanded this change be made. The DLIR has become an ongoing programme, thus ensuring the airworthiness of the Sea King and significantly contributing to its long service life.

Nineteen eighty-four also saw the commencement of the Automatic Stabilization Equipment (ASE) Reliability Improvement Program. At that point, the ASE mean time between failure (MTBF) was approximately 4 hours—essentially, one could expect the ASE to fail on every flight. IMP Avionics Division had acquired the worldwide licensing rights for the ASE from Hamilton Sundstrand and, thus, had the technical data required to address the problem. As with most Sea King issues, price was a strong determinant of the likelihood of a programme being funded. In this case, the engineers determined that the problem could be rectified by simply stripping all the parts off the boards and replacing them with new items—only obsolete parts were updated. As a result of this work, the ASE mean time between failure rose to 400 hours. Based on the success of this, IMP Aerospace conducted a similar programme for the United States Navy (USN) Sea King fleet in 1993.

The years 1986 to 1989 brought the installation of the Helicopter Acoustic Processing System (HAPS). This system consisted of a SBP4-1 (AN/UYS-503) acoustic data processor, an AN/ASN-123 tactical navigation system, an AN/ARR-75 sonobouy receiver, an M14-E tape recorder and the interfacing equipment. It was installed only on CH12411, which was subsequently lost at sea due to loss of the main gearbox oil. The full fleet had the AN/APN-503 Doppler system replaced with the state-of-the-art AN/APN-513 Doppler radar set. This new Doppler system allowed the fleet to return to night-hover operations from which they had been restricted due to safety concerns with the old system. To improve the low-speed directional control, especially the right sideways movement, a strake was fitted to the left side of the tail cone. The strake broke the symmetry of the airflow over the tail cone, essentially turning it into a wing. This reduced the power required at the tail rotor to maintain straight flight. Operational capability was improved by replacing the outdated AN/ARC-552 ultra-high frequency (UHF) radio with the AN/ARC-164 (V) UHF radio and replacing the KY-28 with the KY-58/KY-78 secure voice system. Crew safety was improved with the installation of an improved low RRPM warning system. The requirement resulted from the flight safety investigation into the crash of the waterbird. The installation was designed by IMP Aerospace; it produced a higher volume and progressively faster beep rate as the RRPM dropped. The crashed waterbird aircraft (CH12425) was also rebuilt. During this period, an engine firewall web was reinforced to prevent cracking.

The summer of 1990 provided perhaps the greatest challenge the Sea King operational, maintenance and engineering communities ever faced. In response to the United Nations mandate to remove the Iraqi military from Kuwait, Canada offered to provide three ships for interdiction and control duties in the Persian Gulf. This required that six Sea Kings be reconfigured from an ASW to surface-surveillance role in 10 working days. The ASW equipment was removed, but the wiring, fittings, etc. were left in place should an ASW threat arise. A self-defence suite—consisting of an AN/ALQ-144 infrared countermeasures system (bottom mounted), M130 chaff and flare dispenser, AN/ALE-37 Electronic Countermeasures Dispenser and AN/APR-39(V) Radar Warning Receiver—was installed. Other systems included a forward looking infra-red (FLIR) 2000 system, Trimble Trimpack global positioning system (GPS), C9 light machine gun (5.65 millimetre), laser warning receiver, and aircrew seat pan armour. Considered but not installed due to time, procurement or testing constraints were the AN/AAR-47 Missile Approach Warning System, KY-75 HF Secure Voice, AN/ARC-164 Have Quick Modifications and AUTOCAT UHF Relay. Ten minor aviation life support equipment (ALSE) and safety systems modifications were carried out concurrent to the aircraft modification activity.

From 1992 to 1995, the CH124B was introduced; it was a CH124A from which all the active ASW equipment was removed and replaced by the Helicopter Towed Array Support (HELTAS) system. The system consisted of an AN/UYS-503 acoustic processor / sonobouy command system, AN/ARR-75 sonobouy receiver system, AN/ARC-164 UHF radio, AN/ASQ Advanced Integrated Magnetic Anomaly Detector in the tail cone, the AN/ASN-123C tactical navigation system and sonobouy stowage rack. Also installed were an M14-E tape recorder, a time code generator and a Magnetic Anomaly Detector (MAD) chart recorder. The purpose of the HELTAS system was to work with ships equipped with CANTASS (Canadian Towed Array Sonar System) to enable operational training and development of passive acoustics tactics in anticipation of the arrival of the Sea King replacement helicopter.

During this same period, frequent cracking of the aluminum upper pylon hinge fitting was experienced. In order to reduce the inspection and maintenance burden, a steel fitting was installed. In keeping with the adage that no good deed goes unpunished, the added weight of the steel fitting pushed the already aft-tending centre of gravity of the aircraft to one in which certain manoeuvres and fuel loads resulted in an out-of-tolerance condition. To correct this, IMP Aerospace developed a centre of gravity improvement modification, which relocated avionics components forward into the electronics bay. This resulted in the forward shifting of the basic centre of gravity by approximately 4 inches [10.2 centimetres] and a return to the aircraft flying like it used to.

From 1997 to 1998, in an effort to increase capability and commonality, the CH124A had the same AN/ASN-123C tactical navigation system as the CH124B installed, and the CH124B had the same FLIR system as the CH124A installed. Both models had the AN/ARN-127 VHF Omnidirectional Range / instrument landing system (VOR/ILS) navigation system installed. Both models also had an electric wiper/washer system installed, replacing the no-longer-supportable hydraulic system. The lower aft sponson support fittings were replaced with a fitting which had thicker lugs, allowing for more rework before the fitting required replacement.

In 1999, a major structural modification, known as the Centre Section Replacement Program, was undertaken to replace the main lift frames. Web cracking, which was first discovered in 1972, was a common problem. Repair schemes were developed and incorporated, but the cracking continued to the point that there started to be repairs on the repairs, making the design and analysis very difficult. In 1994, IMP Aerospace produced a report on the condition and status of all the aircraft. It found that airframe hours ranged from 6,000 to 10,000; there was no correlation between the presence of cracks and the Bureau Number (i.e., the cracking seemed to be randomly spread about the build sequence), and airframes had anywhere between no cracks to five cracks. The report found 4 aircraft with cap angle cracks and 27 with web cracks. DND followed the USN approach and replaced the centre section on the fleet. This replacement was based on the Sikorsky design that was developed for the USN. IMP Aerospace adapted the modification to meet the requirements and peculiarities of the Canadian Sea Kings. The programme consisted of replacing the affected main lift frames from the floor level up and installing new main gearbox and sponson mounting fittings. This programme essentially restored the most highly stressed portion of the airframe to an as-new condition.

During the same period, an IMP Aerospace initiative to improve an internal bulkhead to prevent cracking was undertaken. There was a long history of cracking of the “T” fittings which are used to attach the tail cone to the aft fuselage. While the cracks did not pose a serious issue to safety of flight, there was a considerable maintenance and aircraft unavailability burden associated with the repairs. The USN and Royal Navy solution was an aluminum strap which reinforced the joint. This had the consequence of adding considerable aft weight—not good—and making tail cone removal very difficult. IMP Aerospace investigated the problem and determined that imprecise alignment of the “T” fittings during assembly was resulting in a preload and, hence, higher stress on the fittings, resulting in overload and cracking. The solution developed consisted of jigs for both the fuselage and pylon, which ensured perfect alignment of the fittings. There has been next to no cracking found since this programme was instituted.

In the 1999 to 2002 period, two significant upgrade programmes were undertaken. Parts for the T58-8F engine were becoming scarce, as many military operators shifted to the T58-401 version of the engine. The overhaul provider for the CF Sea Kings proposed that the engines be converted to the commercial CT-58-100. This conversion resulted in an increased available power to 1,500 horsepower [1,118.5 kilowatts] and improved availability of parts.

In October of 1996, Sea King 12424 lost power and crashed on the deck of HMCS HURON. The flight safety investigation concluded that the loss of power was possibly the result of a phenomenon known as "freewheel roller spit out," wherein the freewheel unit momentarily loses the ability to transmit engine power to the main gearbox. The solution to this was to install the 24000 Series main gearbox, which commenced in 1999. This main gearbox had changes which improved the freewheel unit reliability; included an emergency lubrication system which provided an improved probability to land safely in the event of lubrication oil loss; strengthened certain gears and housings; and had external filter bowl attachment bolts, addressing an earlier problem with filter bowl retention.

During this period, the C6 General Purpose Machine Gun (7.62 millimetres) was installed. Also, the aircraft-side sponson attachment fittings were replaced (on an attrition basis) with items having thicker lugs, enabling more rework before the units required replacement.

In 2000, the CF introduced a completely new system of airworthiness. One of the consequences was the requirement for technician training to include a minimum of 5 per cent hands-on work on the aircraft. To meet this stipulation, an otherwise operational aircraft was permanently assigned to 406 (Helicopter Training [HT]) Squadron as a maintenance trainer. In 2004, CH12401 crashed on deck. IMP Aerospace inspected the aircraft and determined that it was feasible to rebuild it as a category one maintenance trainer, allowing the aircraft at 406 Squadron to return to the operational fleet. To meet the requirement as a maintenance trainer, it had to be safe to apply electrical power to the aircraft and all avionics and mechanical components had to be installed. The essential structure was replaced, and non-airworthy repairs were installed where possible (e.g., in the boat hull area where personnel did not go.) All non-airworthy repairs were recorded in case the aircraft had to be rebuilt as a flyer. To shorten the time required to accomplish the rebuild, IMP Aerospace requested, and was approved, to use parts from a USN SH-3 which was in the process of being struck and scrapped. The structural parts from this aircraft were used in the non-airworthy repairs.

In January of 2006, the CF began discussions and feasibility evaluations on the development of Standing Contingency Task Force (SCTF) which would require the use of Sea Kings in a troop-transport and utility-support role. A decision was made that the five remaining CH124Bs would be converted for this role. While not quite of the same magnitude of change, and certainly with a longer developmental time frame (eight months for design, installation and delivery of the aircraft) than the Operation FRICTION programme, the SCTF nonetheless required a solid focus on the goal by IMP Aerospace Engineering, Production and Material Departments. The role change consisted of removing all the passive acoustic sensor equipment and the internal stores system. To be installed were 14 crashworthy seats; equipment-securing nets (an army platoon carries an incredible amount and variety of equipment); an entrance step and handholds to ease the loading and disembarkation of the troops; a cabin liner to prevent snagging of equipment; and three overhead crew restraints to replace the single, floor-level restraint. An AN/ARC-210 multi-band radio for communications was also installed, based upon an Aerospace and Telecommunications Engineering Support Squadron (ATESS) design. The major design constraints were the requirement for 14 seats (so a platoon could be carried in two helicopter lifts) and that the side-facing console had to remain installed. This required some interesting engineering approaches to get the seats sufficiently forward to keep the centre of gravity within limits.

Based on an Australian Sea King crash in which the passengers were killed, the CF Flight Safety branch mandated the installation of crashworthy passenger seats in the CH124A fleet. The seats and installation design were based on the CH124B troop seats, with some changes to the underfloor design to enable the modification to be incorporated without removing the fuel cells. At the same time, the CH124B seat attachments were modified so three seats could also be installed in the same position as in the CH124A, allowing a common bathtub to be fitted.

While investigating a problem where engine power would suddenly drop, an instrument panel video monitoring system (IPVMS), consisting of a video camera in the cockpit to record the flight instruments and a tape recorder to save the data, was installed. In 2006, an IPVMS upgrade was designed which replaced the tape recorder with a digital recorder. The intercom system was also fed into the recorder to serve as a cockpit voice recorder.

In 2009, the Sea King lighting system was modified with filters, lenses and lights to make it night-vision-goggle compatible.

From 2010 to present, the approach has been to not spend money on the Sea King, as it is going away. Slippage of the CH148 Cyclone delivery schedule, however, may result in Transport Canada mandating the installation of a 406 megahertz (MHz) emergency locator and a 406 MHz crash position indicator. The installation of the AN/ARC-210 multi-band radio in the CH124A is a potential capability improvement.

Conclusion

As can be seen from the above, while a superficial glance at a current Sea King doesn't show much change from the 1963 Sea King, considerable effort has been expended to improve the safety, reliability, maintainability and operational effectiveness of the helicopter in its 2013 form—that's 50 years after having been extruded through the doors of Pratt and Whitney Canada. This success story is a perfect example of the happy confluence of a number of organizations which came together to pursue a common goal. It was the capability that developed from those drivers that became the depot-level support programme for the Sea King, a clearly invaluable contributor to sustaining one of Sikorsky's most successful products.

Terry Robbins

Terry Robbins has 35 years' experience in the management of aircraft and weapon systems engineering, including design, modification, testing as well as repair and overhaul. Of that, 24 years has been in direct association with the Sea King helicopter in both military and civilian functions.

Terry began his career at 12 Wing Shearwater, serving as a first line Sea King maintenance officer at 423 Maritime Helicopter Squadron that included an operational deployment aboard Her Majesty's Canadian Ship (HMCS) PRESERVER. This was followed by a staff position in National Defence Headquarters (NDHQ), a technical services detachment quality assurance role at IMP Aerospace and a second posting as the Air Maintenance Officer in HMCS PRESERVER. It was then back to NDHQ where he broadened his experience in project management and engineering support as the Sea King Aircraft Engineering Officer. His efforts there were rewarded with a most enjoyable tour as the H 3 Project Officer on exchange with the United States Navy at the Naval Aviation Depot (NADEP) in Pensacola, Florida. His last military posting was as Systems Engineering Manager for the Maritime Helicopter Program.

His first civilian job was with SPAR Aviation Services, where he supported the repair and overhaul of dynamic components for the Sea King fleets of the Canadian Forces, United States Navy, Brazilian Navy and Royal Malaysian Air Force. This was followed by a move to IMP Aerospace in Halifax, where he established the maintenance programme for the Cormorant search and rescue helicopter. He then spent several years as the Engineering Manager for the rotary-wing programmes, providing engineering services in support of the Sea King and Cormorant. He is currently employed as a proposal manager.

Terry has a degree in Mechanical Engineering from the University of New Brunswick. During his military career he received the Chief of the Defence Staff Commendation for his leadership in preparing the Sea Kings for Operation FRICTION and the Secretary of the United States Navy Commendation for his work at Naval Aviation Depot, Pensacola.

Chapter 9

Sea Kings in Somalia

Jim Cottingham

Operations CORDON and DELIVERANCE, Somalia 1992–1993

In the winter of 1992/93, Her Majesty's Canadian Ship (HMCS) PRESERVER, with its air detachment of three Sea King helicopters, went to Somalia as part of an international coalition attempting to restore order to the drought and civil-war ravaged country, permitting relief agencies to bring assistance to the people of Somalia.

During this deployment, our Sea Kings faced challenges and successfully undertook tasks that had never before been imagined by anyone in the maritime-helicopter community. What follows in this article are my recollections of the deployment.

How We Got to Somalia

In 1992, a terrible famine was ravaging Eastern Africa, and in the failed state of Somalia, civil war was raging as well. For their own strategic purposes, Somali factions on all sides of the conflict were attempting to control access to food; whether it was locally produced or brought in from abroad by international relief agencies. The end result was a cessation of the flow of international food aid to the people who needed it, steadily worsening the humanitarian situation to catastrophic proportions. In early 1992, it was estimated that at least 300,000 people had perished and that nearly 4.5 million people were threatened with imminent starvation.[1]

In order to relieve the situation, the United Nations (UN) adopted three resolutions:

a. United Nations Security Council Resolution (UNSCR) 751 (24 April 1992) introduced un-armed observers into Somalia (approximately 50 in number) and a 500-man strong infantry unit to "provide the United Nations convoys of relief supplies with a sufficiently strong military escort to deter attack and to fire effectively in self-defence if deterrence should not prove effective."[2]

b. UNSCR 767 (27 July 1992) called for the "deployment of UN security forces in two parts of the country. The first was for Bossasso in the north-east, to help provide security at the port, escort convoys of relief supplies to distribution centres and protect them during distribution. The second was to escort relief convoys overland to a new 'preventative zone' in the Gedo region of Somalia along the border with Kenya."[3]

c. UNSCR 775 (28 Aug 1992) called upon its members to contribute a total of 4,219 troops and 50 military observers to provide security in four regions of the country—Bossasso and Gedo, as previously mentioned, as well as new areas centred on Berbera and Kismayo.

On 14 September 1992, Pakistani troops—the 500-man unit authorized under UNSCR 751—arrived in the Mogadishu area and attempted to conduct their assigned mission.

Meanwhile back in Shearwater, Nova Scotia, much of the happenings in East Africa were very much in the background, and other than the news reports of the ongoing famine, I knew very little of the events that were transpiring in New York and Somalia. We were all looking forward to the arrival of the new shipborne aircraft in a few years and were ready to make the transition to a state-of-the-art aircraft and weapons system. It was "a great time to be Helicopter Squadron."

For those of us in 423 Helicopter Anti-Submarine Squadron—or HS 423 as it was then known—and more specifically for those of us who formed the squadron's helicopter air detachment (HELAIRDET) on board the fleet replenishment ship HMCS PRESERVER, the first half of 1992 was a busy, but normal, year. The detachment spent the months of May and June undergoing work-ups and a series of exercises at sea with the ship. As I recall, the exercises were lots of fun, with lots of time spent chasing simulated submarines in cooperation with surface ships and shore-based maritime-patrol aircraft.

By late summer and into early September, we began to hear rumblings that the ship—and that included us on the HELAIRDET—would be involved in an operation in Somalia. Slowly, details began to emerge that a battle group (BG), based on the Canadian Airborne Regiment (CABR), was being considered for deployment to Bossasso in northern Somalia under the auspices of UNSCR 767. We gathered that our ship was to deploy along with the CABR to:

a. deliver stores and support the CABR ashore;

b. assist with port security; and

c. provide humanitarian relief assistance when and where able.

The details of our mission were very vague, and little in the way of a concept of operations trickled down—at least to me. My analysis of what little I knew led me to propose that we maximize the air capability on the ship by sending three helicopters and four crews. Part of the rationale for three helicopters was so that we should be able to keep two of them flying by using the third for spare parts. There were two reasons for four crews: first, you need four crews to embark/disembark three helicopters, and second, and most importantly, getting four crews to sea on a long deployment was a very good way to allow junior crew members to gain experience and progress their upgrade training.

In addition, the proposed concept of operations called for us to remodify the three helicopters to a configuration similar to that used during the Gulf War. We certainly wouldn't be facing a threat from submarines, so the antisubmarine warfare (ASW) gear was not required. Instead, I expected that we would need the strengthened floor boards and additional troop seats to conduct an enhanced helicopter delivery service (HDS) mission, forward looking infra-red (FLIR) and night vision goggles (NVGs—for the observer at the cargo door) to conduct night surveillance around the ship and the approaches to the harbour as well as a C9 light machine gun at the door for self defence.

The concept was eventually accepted, and the only hitch was that there were not three formerly Gulf-modified helicopters with sufficient hours to periodic inspection to deploy. Two were available, so we wound up with two helicopters with the full kit and one with everything but the door gun.[4]

However, all of our preparations seemed to be for naught as our warning order was not followed up with anything further. No decisions on the mission had been reached in Ottawa, and of course, the rumour mill worked overtime, telling us one day we were going and that the whole thing would be called off on the next. Rather than waste our time in harbour waiting for a decision, the ship sailed for naval exercises in October—in full ASW configuration. We had a great time practicing our tried and true role with the Navy and returned home on 26 October to find that our mission was now back on and that we would be leaving on 16 November for an anticipated four-month deployment.

On 13 November, forces under the control of General Mohamed Farrah Hassan Aidid, a Somali warlord, shelled and fired on the Pakistani troops stationed at the Mogadishu airport, causing them to return fire in self-defence; meanwhile, forces under the control of Ali Mahdi began shelling food aid ships attempting to enter the port of Mogadishu.[5] Three days later, we embarked with great fanfare as part of Operation (Op) CORDON—the Canadian Forces (CF) contribution to the UN.

Our transit across the Atlantic, through the Mediterranean, the Suez Canal and into the Red Sea was uneventful but busy; we were fully occupied with damage-control exercises and crew training, including developing proficiency with the use of the door guns and personal side arms.

Back in those days, we did not have satellite communications to speak of, and there was no Internet or email available to us as our HELAIRDETs have today. News of events transpiring in Somalia was sparse at best, and we were blissfully unaware of what was going on in the world.

The situation on the ground continued to worsen. The Pakistani contingent with the United Nations Mission in Somalia (UNISOM) were holed up in a defensive position at the Mogadishu airport, and Aidid had "grown confident enough to defy the Security Council formally and demand the withdrawal of peacekeepers, as well as declaring hostile intent against any further UN deployments."[6] In response, the UN Secretary General, Boutros Boutros-Ghali gained the support of the Security Council for invoking Chapter VII of the UN charter to restore peace. This invocation would permit UN troops to act "as may be necessary to maintain or restore international peace and security," and as importantly, it waived the need for the state of Somalia to consent to the presence of UN forces.[7] Accordingly, on 3 December, the Council passed UNSCR 794, authorizing a country-wide enforcement operation by willing member states under a Chapter VII mandate.

On that same day, 3 December, we on the ship got word that Op CORDON was off and that we were no longer going to Bossasso. Over the next few days, we learned that we were being sent to Mombasa, Kenya, to replenish our stocks and have a port visit. I suspect that we were sent to port to park us somewhere while the folks in National Defence Headquarters figured out what the exact CF contribution to what was now being called Op RESTORE HOPE was to be.

In time, we learned that our new CF operation was called Op DELIVERANCE and that the CABR was going to deploy to a place called Bale Dogle—a former Somali Air Force fighter base situated 50 nautical miles (NM, 93 kilometres [km]) inland from Mogadishu. Our immediate mission would be to get the Army's stores from the ship to them as quickly as possible.

Getting the Heavy Goods Ashore

As the ship approached Mogadishu, Wally Workman and Todd Smart led the task of prioritizing the offload sequences to ensure that the troops ashore received the most urgently required items first while the rest of us figured out how we would move the goods from the storage areas on the ship, through the dispersal area, to the flight deck and thence ashore. The solution was to permanently remove the "soft patch hatch" on the starboard side of the flight deck so that a forklift could move cargo pallets down the starboard breezeway and lift them up to the flight deck where a second forklift would take the pallet and either position it on the flight deck or in the hangar for temporary storage.

Flying off the loads was to be done with two helicopters, with each making two round trips to the town of Bale Dogle before hot refuelling. Given the heat and the resulting density altitudes, this meant that the first load lifted after refuelling could only be in the order of 1,000 pounds (lb, 454 kilograms [kg]). On the second lift, with less fuel in the tanks, we were capable of lifting 2,000-lb (907-kg) loads.

With our offload plan ready, the ship arrived off Mogadishu on 13 December. The CABR was due to begin arrival in Bale Dogle by CC130 lift on 15 December, and we wanted to ensure that water and the highest priority stores were waiting for them when they arrived. Thus, we conducted an inspection of Bale Dogle on 13 December to plan out where we would drop the load and deploy a naval security party, cargo handlers and cargo-handling equipment.

Our cargo moving operations began the following morning. As luck would have it, the first launch was delayed a few hours due to a maintenance issue. After we finally got the birds in the air, all went according to plan except that, due to the shortened day, we only achieved 9 of the 16 lifts planned for that day, for a total of 18,000 lb (8,164 kg). The second day went much better, and we moved over 28,000 lb (12,700 kg), ensuring that the essential stores were in Bale Dogle in time for the CABR's arrival. However, on the last lift, one of the helicopters got a blade pressure warning and had to shut down and spend the night at Bale Dogle. On the third day, we lost time dispatching a mobile repair party (MRP) to rescue our sick bird and only moved a disappointing 15,000 lb (6,804 kg).

Since the fuel/load trade-off was such a serious issue, we carried just enough fuel to allow for the two round trips and a small reserve; therefore, minimizing time spent picking up and delivering the loads became critical. To save time while delivering loads, we simply placed the load on the ground, released the cargo strop and flew back to the ship, leaving the strop and cargo net with the load. This procedure saved us the few minutes that it would have taken to place the load on the ground, have a ground crewman come under the helicopter to electrically ground the strop and unhook it from the load and then depart to a place of safety before we could fly away. Fortunately, the ship carried a good number of cargo strops and cargo nets. However, the supply was not inexhaustible, so on our last run of the day, we flew with enough fuel to pick up the gear that we had used that day and return it to the ship for use on the following day.

We amended normal procedure to save time when picking up the loads from the ship as well. Normally, a crew would hover over the prepared load, lower the messenger (a guide wire which, because of its design, started in slow speed as the messenger passed through and cleared the main probe and then switched to high speed until stopped by the pilot), have a crewman come under the helicopter, hook up the messenger to the cargo strop, raise the messenger until the strop was secured in the helicopter's main probe and, after the ground crew were in a place of safety, lift the load from the deck and fly away. Our solution was to begin lowering the messenger on approach to the ship to the point where the messenger winch had switched into high speed. Thus, when we arrived over the deck, the messenger was in the deck crew's hands and hooked to the strop within a few seconds instead of the one–two minutes it would normally have taken. While the time savings were small, they did help with the fuel/payload trade off, and as importantly, they gave the ground crews more time to manoeuvre pallets and to prepare and break down loads at either end.

While the slinging operation was beginning to run smoothly, it was obvious that we needed to find both a quicker way to get the stores inland as well as some way to minimize helicopter flying time lest we run out of hours on the aircraft before the operation was complete. Fortunately, Lieutenant-Colonel Roger Sorsdhal, our Squadron Commanding Officer who was visiting us at the time, was able to convince the CF commander, Colonel Serge Labbé, to assign a CC130 to the effort. This enabled us to move stores from the ship to the nearby Mogadishu airport for transhipment to a waiting CC130 and subsequent airlift to the CABR. We began this shorter-transit operation on 16 December and, using only one helicopter, moved 64,000 lb (29,030 kg) off the ship in a single day.

The only problem with lifting loads to Mogadishu was the congestion at the airport. As Sam Michaud described it, "I'm not sure if there is an airport here anymore or if it is just a parking lot for airplanes." Finding a safe place to put the loads down was very difficult, and some days we were denied access to the airport due to the congestion. So we brought our loads in when we could, sometimes drawing the ire of the captains of parked aircraft and the residents of the rapidly expanding tent cities surrounding the airfield, as we kicked up dust and small stones from our rotor wash during the transit to and from the drop area. In spite of these difficulties however, we managed to bring the total of cargo slung ashore to 533,208 lb (241,859 kg) by the end of the month.

Personnel/Light-Load Delivery

As our work moving cargo by external slung load began to wind down during the month of December, we began to shift our priority to the movement of passengers and high-value/high-priority cargo that could be carried as internal loads.

The Canadian Joint Task Force headquarters (HQ) was embarked on the ship, and there was heavy demand to transport the commander and his staff between the ship, the Mogadishu airport, the Mogadishu sea port, the coalition's Unified Task Force (UNITAF) HQ (located at the site of the former United States (US) embassy compound in Mogadishu) and Bale Dogle. Moreover, the ship's crew was heavily committed to the delivery of aid in the form of construction crews who worked to build/repair schools as well as medical and dental teams who delivered much needed health care to the people of the city. In addition to CF personnel moving from ship to shore, there were also members of the news media and non-governmental organizations (NGOs) aid workers to be transported from place to place. In short, there was a constant demand to move lots of people, tools, equipment and supplies every day.

There were only two ways to get from ship to shore and back. The first was a combination boat and road trip involving a wet, bumpy (and quite exhilarating) high-speed run in the ship's rigid-hull inflatable boat (RHIB) followed by a ride in an armed convoy through the streets of Mogadishu. The alternative was via the faster and relatively more comfortable helicopter. The high demand for transport meant that both alternatives were used extensively; the ship's RHIB and Sea King taxi service ran from dawn to dusk each day.

As all of our helicopters had been configured with extra troop seats and strengthened cabin floors to permit carriage of internal cargo, this task was relatively easy and natural for us to undertake. We moved large numbers of people each day—especially on the days that we had two aircraft on the flying programme. Unfortunately, the detachment only carried six sets of safety gear (helmets with visors and life vests), resulting in lengthy delays while the gear was switched between offloading and on loading passengers. We soon solved this by dipping into the ship's supplies of goggles, ear defenders and life vests to provide our passengers with not only sufficient protection to reduce the risk of eye or hearing damage but also emergency flotation to an acceptable level. In very short order, all of our air and ground crews became very efficient at loading and unloading personnel and cargo while the rotors were running, making our airborne taxi service as fast and efficient as it could be.

Surveillance and Reconnaissance in Mogadishu and Belet Uen

On 22 December, Kirk Binns and his crew[8] flew our first overland reconnaissance mission in support of the coalition land forces. Shortly after dropping off a slung load at the Mogadishu airport, the crew was redirected to pick up a three-man United States Marine Corps (USMC) intelligence team to conduct a low-level mission over the city in search of ammunition dumps, crew-served weapons and groups of Somali fighters. At the end of the flight, the USMC team seemed quite happy with the imagery taken from the cameras that they had brought with them as well as with the video / still imagery from our own on-board cameras.[9] They were also very interested to see the imagery available from our FLIR system because, as we later learned, our FLIR-equipped helicopters were the only aircraft in the coalition with the capability to conduct night surveillance. For the next three-four weeks, we conducted a number of low-level day reconnaissance missions of Mogadishu, fitting them in with our other tasks when we could.

On 26 December, my crew[10] flew Colonel Labbé, a couple of his key staff officers and a few senior USMC officers to Belet Uen[11] to conduct an airborne reconnaissance of the city and its surrounding areas. Canada had agreed to take on responsibility for the Belet Uen Humanitarian Relief Sector (HRS) centred on the town bearing the same name. The distance from the ship's anchorage off Mogadishu to Belet Uen was approximately 165 NM (306 km). There was no way to refuel a Sea King at Belet Uen, and as far as we knew, there were no coalition forces in the area. To conduct the mission, we picked up our passengers at the Unified Task Force HQ in Mogadishu and flew to Bale Dogle to hot refuel from a USMC fuel farm that had been recently established at the old airfield. From there, we flew the 125-NM (230-km) transit to Belet Uen and conducted aerial reconnaissance of the general area with a specific focus on the proposed location for the CABR BG base camp. We had only enough fuel to make a couple of circuits of the area before retracing our steps to Bale Dogle, the HQ and home to the ship.

Early in January, the CABR BG deployed to Belet Uen. In order to deter the local clansmen from attempting violence against the coalition forces, the BG wanted to demonstrate its capabilities and combat power to clan leaders. In particular, they wished to show that the Canadians were the "technicals" who never sleep,[12] who could see and react to anything that took place in their sector—24 hours a day, seven days a week. Given the night-time surveillance capability offered by the FLIR and NVGs on our Sea Kings, it was not surprising that the air detachment soon found itself planning long-range patrols in the Belet Uen HRS.

We flew our first night-surveillance mission to the Belet Uen area on 11 January, refuelling in Bale Dogle on the inbound and outbound legs. Unfortunately, this allowed for little more than 1 hour of time on patrol in the Belet Uen area. On 19 January, we greatly increased our on-patrol station time thanks to some excellent legwork by Shearwater. On that date, a forward area refuelling equipment (FARE) system was established at Belet Uen, and this now meant that we could fly directly to Belet Uen, pressure-refuel, launch for a nearly 3-hour patrol, refuel once more and return to PRESERVER. Using the FARE, our sorties were typically 8 hours in duration. The record was held by Mike Evans' crew[13] who, on 16 February, flew a 9.3 hour mission. The reason for the longer duration was that they observed so much combat activity on the ground during their patrol that it took extra time to identify, record and report the positions of the combatants.

During most of these night-surveillance missions, we carried an extra airborne electronic sensor operator (AESOP) on board so that we could have two spotters with NVGs looking out—one at the cargo door manning the door gun looking to starboard and the other on the port side, sitting on the multiplace life raft, looking out the empty port window (the window was removed). The tactical control officer (TACCO) ran the navigation, communications and the FLIR, and the pilots were, of course, in the cockpit flying by instruments and without NVGs, as the Sea King cockpit was not NVG compatible. Our ingenious AESOPs rigged up a set of extremely effective blackout curtains from ship's blankets. Not only did they remain in place in spite of the large volume of air moving through the helicopter with all of its doors and windows open or removed, but they were also excellent at trapping the light generated by the FLIR display in the tactical compartment and keeping the after cabin and the cockpit in total darkness. Thus, the NVGs delivered optimum performance, and the pilots were able to develop very good night vision; on all but the darkest of nights, they were able to spot objects on the ground and maintain very good external situational awareness.

Our most useful night sensor was the FLIR. With it, we could identify vehicles by type, count the number of people as well as identify what kit they were carrying and what types of weapons they were carrying or using. However, it was the ability to record the FLIR display that made our flights most useful. Our video tapes allowed the Canadian Airborne Regiment Battle Group intelligence staff to see everything that we saw, albeit a few hours after we saw it, providing them with a useful piece for their intelligence puzzle. On a few occasions, Colonel Labbé reportedly showed some of our video to local Somali leaders to demonstrate to them that darkness could not hide them from us. Our tapes were even used by Canadian television news crews in their coverage of CF operations in Somalia.[14]

The flight profiles that we flew were not significantly different from what we were very used to. Thankfully, the terrain was generally quite flat, so a crew that was comfortable flying our normal over-water profile at 150 feet (45.7 metres [m]) on instruments did not have much difficulty adapting to flying on instruments over land at higher altitudes. That is not to say that these missions were not flown without increased risk. The significant risk was, however, not from the terrain but from the ever-present danger of gunfire being directed at us. In order to minimize this risk, we flew without lights and did our best to remain unseen to people on the ground by being very aware of reflected light from the ground giving us away. To be sure, they certainly heard us, and I expect that some probably did shoot to where their ears told them we were. Thus, any gunfire directed toward us was very inaccurate, and thankfully, we were never hit. We continued to fly the night-surveillance missions and moved people and cargo while the ship was at anchor off Mogadishu until 19 February.[15] During this period, we also flew other missions of note.

Convoy Escort

The roll-on/roll-off (RoRo) ships carrying the BG's vehicles and heavy equipment arrived in Mogadishu on 6 January and began unloading. The Canadian Task Force logistics staff and our ship's crew worked hard to get the vehicles ready and load them with tons of cargo in preparation for the long road move to Belet Uen.

The ship's captain and crew were very keen to help the BG during the two-day road move. The ship's company provided co-drivers and support personnel to minimize the requirement to take soldiers off patrol in Belet Uen to run the convoy.

For the Sea King crews, the convoy move was a nice change from our other missions. We flew route reconnaissance missions along the road from Mogadishu to Belet Uen and delivered fuel and water in bladders as well as security personnel to the intended overnight stop point. When the convoy began to roll on 14 January, we flew continuous top cover escort flights until the convoy stopped for the night and then resumed when they began moving the next day until the convoy neared Belet Uen.

On these escort flights, we flew ahead of the convoy looking for potential ambushes and impromptu "toll" stations that the locals would set up to extort money from any passer-by. We did not encounter any ambushes (or perhaps we frightened them off), but we did come across the occasional roadblock. Unfortunately, communicating the information to the convoy was problematic. The ultra-high frequency (UHF) man-pack radios that the Army would normally use to communicate with military aircraft had been left behind in Canada, so we attempted to communicate via high-frequency (HF) radio. However, the static noise on the HF frequencies that we had been assigned was so great that we were unable to talk to the troops on the ground—even when we were within visual range of each other. We solved this problem by reverting to World War I techniques: hand signals, written messages dropped from the air or by simply landing nearby and walking over to them to point out the roadblocks on the map.

Casualty Evacuation

On 19 January, Sam Michaud and his crew[16] were en route to Bale Dogle to pick up passengers when they came upon the scene of a vehicle accident some 35 miles (56.3 km) north of Mogadishu. They observed that the second element of a large US convoy was stopped on the road near an overturned Somali truck that had apparently been full of people.

Sam circled the scene and, after finally establishing radio communications with the US troops on the guard frequency, learned that there were several injured people who required immediate evacuation to hospital. Without hesitation, he landed the helicopter and had the two critical and three serious casualties, one Somali interpreter and one US medic on board the helicopter within a few minutes.

After the Sea King took off and began making its best speed toward the US field hospital at the Mogadishu airport, two US medical-evacuation (MEDEVAC) helicopters arrived on scene looking for the casualties that they had been called in to pick up, only to learn that their casualties were already half way to Mogadishu aboard the Sea King helicopter. We learned later from our ship's doctor, Heather MacKinnon, that because of this incident, the US medical personnel were calling the Canadian Sea Kings "the body snatchers."

As a result of his quick thinking and sound leadership during this and other missions, Sam Michaud was awarded the Meritorious Service Medal (MSM).

Anti-Piracy

On 15 January, my crew and I were en route to escort the vehicle convoy in the final stages of its route to Belet Uen when we were called by the ship and diverted to another task. They relayed to us that other coalition ships had heard a distress call on the ship-ship radio. According to the distress call, pirates were in the process of hijacking the ship's cargo of aid supplies.

We flew to the reported position and found nothing. As the longitude of the position placed us right on the shoreline, I reckoned that whoever had made the distress call had made an error in latitude. We flew 60 NM (111 km) south and found nothing. We then flew toward a position one degree north of the location given in the distress call. I was beginning to suspect that it all might be a hoax when we managed to establish radio communication with the vessel in distress on our marine band radio.

The ship was the Motor Vessel *Red Cross Free Trader*. She was at anchor just offshore of a small coastal village about 100 miles (161 km) north of Mogadishu. We learned by radio that shortly after the ship had unloaded its cargo of relief aid on the beach, a large, well-armed group of Somali bandits had arrived and hijacked the cargo. To make matters worse, the ship's captain, who had been ashore with the cargo, had also been taken hostage.

In short order, we were on scene but remained about a mile (1.6 km) offshore while we assessed the situation. The cargo, which appeared to be bales of grain, was neatly stacked on the beach and a large group of armed Somalis were either on or near the cargo. We saw several trucks nearby that appeared to be getting ready to move toward the cargo to move it away. We learned via radio that gunships and heli-borne troops were en route but were at least 20 minutes away. Concerned that the bandits might be able to load the cargo on the trucks and get away before the gunships and troops arrived, we decided to conduct a demonstration of force to delay the bandits' efforts until help arrived.

As luck would have it, the helicopter we were flying that day was 403—the machine that did not have a door gun. Since a demonstration of force using warning shots was out of the question, we decided to make a series of very low and very fast approaches over the load in the hope that we could frighten the bandits away from the immediate area.

As we began to make the first pass, the crowd around the cargo began to disperse and run toward the village. After our third pass, the beach was empty of people. At about that time, the first of the gunships arrived. We quickly handed the situation over to them and beat a hasty retreat seaward. We later learned that the ship's captain was safely released and the cargo was returned into the hands of the Red Cross aid workers.

For his remarkable skill at the controls of the helicopter and his superb airmanship demonstrated during an action in the presence of an armed adversary, our pilot, United States Navy Lieutenant Paul Esposito, was awarded the United States Air Medal.

Maintenance Issues: Battling Heat and Age

The normal challenges of keeping the Sea Kings mission ready were increased exponentially by the long and complicated supply chain from Canada to a ship off the coast of Somalia and by the hot and dusty conditions that we faced ashore. Luckily, we had fully replenished PRESERVER's account of spare parts before we left Halifax, so we began the operation with a good supply of spares on hand. Most important, however, were our people. Our Air Maintenance Officer, Gary Darch, and our Maintenance Detachment Chief, Wayne Johnson, brilliantly led our crew of skilled maintainers to keep our machines running. It was very rare that we did not have at least one helicopter mission ready. The norm was two, and sometimes we had three helicopters available. Considering that they also accomplished the hot and tiring work of handling cargo on the flight deck and ashore, refuelling—including helicopter in-flight refuelling (HIFR)—and all of the other normal tasks of keeping the Air Department running, their success in producing mission-ready helicopters was nothing short of a miracle.

One of the tougher and more unique challenges that our maintenance team faced was cracking windscreens. I have never known the cause of the problem for certain, but I suspect that the windscreens were cracking due to airframe expansion in the extreme heat. Temperatures approaching 50 degrees Celsius were not unusual on the ramp at the Mogadishu airport. In any case, the windscreens cracked, and our technicians monitored, drill stopped and replaced windscreens on an almost routine basis. Fortunately, as the mission progressed, the temperatures began to cool as we passed the peak heat of the African winter, and the frequency of windscreen cracks lessened.

As luck would have it, helicopter 438 was discovered to have cracked engine mounts on 14 January. As this was one of our two door-gun-equipped helicopters, we were forced to fly the unarmed 403 into situations where we would have been much more comfortable with even the C9 door gun as some sort of self-protection. Thanks to some great legwork back in Shearwater, the metal technician who joined us to replace the engine mounts at sea also came ready to install the door gun mounts on 403. When this was completed, our scheduling of missions was made much easier, as we now had three almost identically configured aircraft.

Another of the challenges brought by the harsh environment was the constant threat of a main gearbox overheat caused by high-torque demands in the high-density altitude conditions in which we flew. We first encountered the problem in December when the crew experienced an overheat and landed. With rotors running on the ground and no torque demand, the gear box cooled down until it was safe to fly again. After this incident, all crews were briefed and aware of the potential for the problem and the procedure to cool the gearbox. Obviously, none of us wanted to have an overheat and be forced to land deep in the desert and in potentially hostile territory. However, the conditions were such that our mission profiles often took us to a point where it was easy to overheat the gearbox, and each crew experienced the phenomenon at least once.

The most memorable of these overheat incidents was experienced by Sam Michaud and his crew on 8 January. In accordance with our new procedure, they landed some distance northwest of the city of Mogadishu. Unfortunately however, after a few minutes, the gear box showed no signs that it was going to cool down this time. To make matters worse, several Somalis were observed to be making their way toward the helicopter. Thanks to the ship's Operations Room Officer (ORO) and his team, USMC Cobra gunships and a troop from the Royal Canadian Dragoons (RCD) Reconnaissance Squadron were quickly dispatched to provide force protection. At the same time, the HELAIRDET quickly readied and launched a second helicopter with an MRP on board. Fortunately, by the time the MRP arrived and joined the Cobras circling overhead, Sam's gear box had finally cooled down, and he launched and returned to the ship with the second Sea King as an escort. I will always be grateful to the USMC and the RCD for their quick response on that day.

On a more light-hearted note, one of our more memorable maintenance issues was caused by a problem on the ship. On 9 February, the ship's 400-hertz (Hz) generator went hard down, leaving us with no AC (alternating current) power to start the helicopters. We tried the normally unreliable DC (direct current) generator and, true to form, it did not work. In these days before the TESLA DC start system, we were stuck. Thanks to the resourcefulness of the ship's company and our maintainers, we were able to borrow a 400-Hz start cart from the CC130 detachment in Nairobi. After bringing the cart aboard by one of the ship's boats and craning it on to the flight deck, we were back in business. For the remainder of our time on station in Somalia, the start cart remained on the flight deck forward of the now permanently open soft patch.

Sometime before we returned it, the crew decided that some redecoration of the start cart was in order. In no-time, it was painted a beautiful ship's side grey colour with the ship's hull number and the words "Royal Canadian Navy" painted on the sides. The top was painted to look like our flight deck complete with all of the markings. I do not know how this paint scheme was received by the CC130 detachment when they finally got it back, but I can imagine that whoever was given the job of returning it to its normal drab green cursed us for some time.

The Battle of Kismayo

On 19 February, PRESERVER left its anchorage off Mogadishu and steamed south toward the Somali city of Kismayo. The reason behind the move was to position our Sea Kings so that we could conduct night reconnaissance of the Kismayo area and the land approaches to the southwest of the city.

The coalition troops in the area were from the US Army along with personnel from the Belgian Navy and Army. It seems that the FLIR footage from our Belet Uen patrols that we had been providing to the coalition intelligence organization had built us quite a reputation, so when the Unified Task Force staff decided they needed more information on the events taking place near Kismayo, they asked for us.

The US Army intelligence staff wanted to try to conceal our presence off Kismayo for as long as possible. Thus, the ship did not anchor but remained on a station just over the horizon and out of visual range of Kismayo. I wanted to ensure that each of our crews had an opportunity to see the terrain in daylight before we flew any night missions. So, on the morning of 20 February, all of the crew commanders and senior pilots made an exciting trip ashore by RHIB and embarked on US Army Blackhawk helicopters for a guided tour of the area.

In this area of Somalia, there was enough moisture to support vegetation dense enough to shield the movement of personnel on the ground. Moreover, the moisture was sufficient to produce a fairly constant thin overcast layer based at 1,000–1,500 feet (305–457 metres). The combination of cloud and vegetation had made it impossible for the US Army helicopters to detect any activity on the ground using their NVGs at night. Thus, we learned why our FLIR-equipped Sea Kings had been requested.

That evening, after dark, we began night operations and flew two sorties over the southwest approaches to Kismayo. For these missions, we carried an extra crew member. Due to the complexity of the navigation problem and the positional accuracy demanded in our reports to the US army, the TACCO could not navigate and operate the FLIR at the same time, so we began carrying a dedicated FLIR operator in addition to the navigator, the two pilots and the two NVG-equipped spotters in the aft cabin. On this first night, all was fairly quiet with little to report.

On 21 February, our first night patrol detected the movement of a large group of Somali warriors moving toward the city. This group, about the size of a reinforced company, made a quick advance from the southwest and commenced an assault of the Somali clan occupying the city. All hell broke loose, and before long, muzzle flashes and tracer rounds were all that one could see with the naked eye. From the vantage point of the ship, it looked like a massive fireworks display.

Some of the fire appeared to de directed skyward. Sam Michaud's crew had one particularly harrowing experience. As they were flying over the city trying to report the position of the warring factions, the door gunner called out: "Tracer starboard! Break port!" Almost at the same time, the port spotter called: "Tracer port! Break starboard!" The co-pilot, Bruce Ploughman, turned to Sam Michaud and calmly made the understatement of the deployment: "I think we should get out of here."

Also on the night of 21 February, Kirk Binns and his crew were diverted and tasked to pick up a gunshot victim and a US Army surgical team and bring them to the ship to use our operating theatre. With a battle raging around them, Kirk and his crew flew a difficult night approach and landing and then, after they had picked up their passengers, an equally difficult departure. The helicopter landed on PRESERVER and the surgical team, assisted by our ship's doctor, were operating on the patient minutes later. The patient survived.

For his courage, leadership and skill during this action, Kirk Binns was awarded a Chief of the Defence Staff Commendation.

The battle raged on for several days, and the combat seemed to intensify as soon as darkness fell. We flew at least two FLIR surveillance missions each night, trying to give the coalition forces an accurate picture of what was happening on the ground around them.

Home Again!

By March, the battle had reached its culminating point; the one-time occupiers of the city had been displaced by the attacking clan and all was, by Somali standards, quiet once again. Our services were no longer required and the ship sailed back north to Mogadishu. On 3 March, our Captain, Captain (Navy) Robin Allen, advised us over the ship's broadcast system that we would be only staying in Mogadishu until 7 March, and then we would be on our way home!

The remainder of our deployment was quite uneventful. We returned through the Suez Canal, visited Athens, Greece, and Cartagena, Spain. We spent our time at sea trying to clean the Somali dust out of our helicopters, re-installing the sonar systems back into the helicopters and attempting to regain flying proficiency in our traditional maritime missions. On 7 April 1993, we returned home to Halifax.

Conclusion

During our 143-day deployment we faced unexpected challenges and were asked to undertake missions that no one had ever anticipated that a Sea King would be asked to perform.

We were able to meet these challenges firstly because we had a superb maintenance detachment, who kept our helicopters running so well that we had no worries that our machines would fail us on some dark night, deep in the deserts of Somalia. Secondly, we were able to conduct these new tasks safely and effectively with the equipment we had because we were well trained and well educated. Our training gave us a skill set that served us well in Somalia. Our education gave us the ability to analyse each new problem thoroughly. We were able to identify potential risks and develop risk mitigation measures to allow us to get the job done.

The Royal Canadian Air Force is about to introduce the Cyclone to finally replace the Sea King. I fully expect that someday in the future, Cyclone crews will be asked to perform tasks that we cannot imagine today. I hope that those crews will have the training and professional education that they will need when the time comes.

Notes

1. United Nations, *The Blue Helmets: A Review of United Nations Peace-keeping* (New York: United Nations Reproduction Section 1996), 287–88.

2. Ibid., 290.

3. Ibid., 292.

4. These were 410, 438 and 403. 403 was not fitted with the gun mount.

5. *Blue Helmets*, 293.

6. "Unified Task Force," Wikipedia, version modified November 24, 2012, accessed December 2, 2013 (content updated), http://en.wikipedia.org/wiki/Unified_Task_Force.

7. Ibid.

8. Kirk Binns, Neil McCarthy, Todd Smart and Buddy McKeigan.

9. At that time, we flew with a digital SLR still camera and a handheld SONY video camera.

10. Paul Esposito, Tim Siebert, myself and Denis Gaudreault.

11. Belet Uen is also spelled as Beleweyne or Belet Weyne. I have used the spelling that was used by Canadian Forces during the operation.

12. Marge Dorge, "The White Technicals Who Never Sleep" in *In the Line of Duty: The Journal of Canadian Joint Forces Somalia 1992-1993*, ed. Ron Pupetz (Canada: National Defence, 1994).

13. Mike Evans, Wally Workman, David Langille and Mike Young. The fifth crew member on that mission would have been one of our other three AESOPs, Buddy McKeigan, Mario Roussel or Denis Gaudreault.

14. Peter Kent's coverage of the mission included night FLIR and daytime video footage shot by our crews.

15. Excluding the period from 28 January to 7 February when PRESERVER conducted a consolidation RAS (replenishment at sea) to replenish her fuel stocks and then an R&R (rest and relaxation) period in Mombasa, Kenya.

16. Sam Michaud, Bruce Ploughman, Steve Cooper and Mario Roussel.

Jim Cottingham

During his 34-year career in the Canadian Forces (CF), Jim spent much of his time either flying on Sea King helicopters or working as a member of various project teams attempting to improve or eventually replace them. The highlights of this stage of his life were the five flying tours, during which he commanded several helicopter air detachments, was the Deputy Commanding Officer of 423 Squadron and Commanding Officer of 443 Squadron.

In addition to a number of staff tours in various headquarters, Jim also served as a member of the directing staff at the Canadian Forces Command and Staff College in Toronto, was a battle commander at Canadian North American Air Defence Command Region in Winnipeg, Manitoba, was the first commanding officer of the Canadian Forces Aerospace Warfare Centre and was the CF National Liaison Representative to North Atlantic Treaty Organization's Supreme Allied Command Transformation in Norfolk, Virginia.

Jim is a graduate of the Royal Australian Air Force Command and Staff College and is a distinguished graduate of the United States Air Force Air War College. He holds a Bachelor of Military Arts and Science, a Graduate Diploma in Management, a Master of Strategic Studies (United States Air University) and a Master of Arts in War Studies (RMC).

Chapter 10

Surviving the Unthinkable: CH124 Importance in Human Factors Survival Training

Michael J. Taber and Albert Bohemier

Introduction

When we challenge ourselves and operate in extreme environments (e.g., bad weather, low visibility and day/night), we invariably put ourselves at risk. The greatest challenges and the highest risks are typically a function of not fully identifying all of the influencing factors associated with the available equipment (combination of old and new), the environment in which particular tasks are being performed, and the capabilities of the personnel performing the tasks.[1] Maritime helicopter (MH) operations are an excellent example of extreme environments that require exceptionally skilled personnel and highly capable equipment. Although the potential for disaster is present during every flight, it is difficult for most people to fully comprehend the stresses that are placed on the human/helicopter/ship interface unless they have experienced a night deck landing in the middle of the North Atlantic in February during a winter storm. If a problem occurs with the flight controls, main or tail gearbox, or engines, the likelihood of landing in the water could be reasonably high, depending on the phase of flight. For example, if the helicopter is in a low hover off the stern of the vessel (delta hover astern) or conducting ship-to-air refuelling operations and there is an engine failure, the likelihood of a ditching can be higher than if the helicopter is directly over the deck.

Evidence of the possible dangers associated with MH operation can be seen in the number of ditching events. Historically, 11 of the original 41 (27 per cent) Sea King airframes have ditched.[2] Table 1 displays the year in which the events occurred as well as the number of fatalities associated with each event. The data contained in Table 1 also highlights the fact that in 5 of the 11 (46 per cent) ditchings, personnel were required to egress from the helicopter after it had submerged below the surface of the water. The data also identifies that in the two events in which there were fatalities (and may, therefore, may have been considered non-survivable) individuals were still able to egress, even after the heavy impact forces. These results illustrate the need for specific underwater egress training.

Year	Fatalities	Ditching Result	# Egressed Underwater
1967	2	Heavy impact	2
1968	0	Inverted immediately	4
1969	0	Remained upright during evacuation	-
1971	3	Heavy impact	1
1973	0	Remained upright during evacuation	-
1983	0	Inverted immediately	4
1987	0	Remained upright during evacuation	-
1989	0	Remained upright during evacuation	-
1993	0	Remained upright during evacuation	-
2000	0	Remained upright during evacuation	-
2006	0	Inverted immediately	5

Table 1. CH124 historical ditching information[3]

Rotary-Wing Underwater Egress Training (RUET)

Research and anecdotal evidence has clearly supported the claim that when a helicopter ditches in water, a considerable number of the crew and passengers must make an escape from a rapidly flooding inverted helicopter.[4] One of the first reported cases of an underwater egress was on November 1, 1944, when Jack Zimmerman had to dive back in the helicopter to rescue his crewman. Stories of harrowing escape from almost certain death prompted the development of one of the first egress training systems (Dilbert Dunker) in the early 1940s.[5] These early devices were specifically designed for fixed-wing pilots,[6] and although not mandatory during the initial years, "dunker training" became part of the MH aircrew indoctrination process. Aircrew members stationed at Canadian Forces Base Shearwater (12 Wing) started egress training in the mid 1970s, and the data contained in Table 1 supports the idea that training helps save lives. Although clearly beneficial in preparing CH124 crewmembers for completing egress tasks in the event of a ditching, the Dilbert Dunker training was based primarily on fixed-wing procedures. Given the limitations of the simulator, crewmembers were unable to practice the specific tasks needed to open a cockpit or upper personnel emergency exit. Nor were they able to practice coordinated egress tasks with multiple personnel (e.g., a cross-cabin egress). These deficiencies in simulator fidelity presumably led to discussions of training validity and began the process of developing a new instructional platform.

A Focus on Realism and High Fidelity

Having completed the Dilbert Dunker training and after surviving a helicopter crash on land, Albert Bohemier (retired Sea King pilot and founder of Survival Systems) decided that a more focused egress-training programme was needed for aircrew and passengers. From the onset, Bohemier's goal was "to enhance and preserve workers' lives through safety education, training technologies, and applied research and development."[7] To achieve this goal, Bohemier developed an innovative survival-training programme that incorporated a Maclean and Gibson (M&G) underwater egress training simulator to better represent the environmental conditions for helicopter aircrew. This approach to egress training was based on the idea that "a trainee success rate approaching 100% in actual emergency egress situations could be achieved with a training protocol that replicated all variables of a true ditching" and that "through learned emergency response techniques, aircrew and passengers could significantly reduce ditching impact injuries."[8]

Using the M&G simulator, Bohemier and his team were able to crudely replicate the interior cabin of the CH124, and for the first time, crewmembers could train and practice their egress skills together. The ability to train as one crew allowed for the development of specific skills that involved a coordinated effort of transferring from one side of the helicopter to the other if a primary exit was inaccessible. This new, larger environment also afforded an opportunity to identify egress difficulties that could not be addressed in the Dilbert Dunker. Specifically, Bohemier and his team started to consider the possibility of snagging hazards, equipment placement, breath-hold capabilities and flotation.

The initial RUET programme in which the M&G was used as the primary instructional platform aided in the development of standard operating procedures (SOP) for egress from the CH124. These SOP were the first of their kind in the Canadian Air Force and would later become standard practice for many of the offshore helicopter crews. This transference of knowledge between civilian and military operations was a result of some military aircrew members transitioning to offshore oil and gas helicopter transport operators, such as Cougar Helicopters. In addition to the SOP being transferred to civilian organizations, many of the safety considerations and equipment placement issues also became part of the offshore helicopter operations. The direct contributions to the civilian aviation community will be discussed in further detail below; however, the next two subsections outline the progress of the simulations used to further enhance the collective understanding of helicopter underwater egress training.

Progress of Egress Training Process

The RUET programme using an M&G simulator began in 1984 and ran until the development of the Modular Egress Training Simulator (METS™) in 1987. Although the M&G simulator was a vast improvement over the Dilbert Dunker, it still lacked many of the features that Bohemier believed to be important in the development of egress skills. For example, the M&G simulator did not have emergency exits that represented the functionality of those found on the CH124. The M&G simulator also lacked the capability to replicate the types of seats and harnesses used in the helicopter. These shortfalls represented a considerable gap between the understanding of how to develop training and the testing protocols necessary to fully prepare crewmembers for a ditching.

Given Bohemier's experience, the new METS™ was developed with the MH community in mind, and the original design was based on the CH124 interior dimensions. Interestingly, the new METS™ also represented the approximate size used to transport offshore workers in the North Sea (EC332 Super Puma) and Canada (S61N). The METS™ was specifically designed and better equipped to simulate more realistic conditions, and its design was centred on one of the fundamental pillars of the organization (applied research). Testing different procedures in this new egress environment meant that specific knowledge could be used to guide future training and safety decisions.

Increased Capabilities

As a greater understanding of the necessary egress tasks developed, Bohemier and his team continued to collaborate with the MH community. During the first two years following the introduction of the new METS™, it became apparent that an even higher level of fidelity would be required to explore egress procedures beyond a rudimentary level. For example, the inversion rate of a helicopter when it capsizes was believed to be an important aspect of disorientation and, ultimately, the ability to egress. To accomplish the goal of more advanced egress investigation, the second generation of METS™ was developed. The METS™ had an increased roll rate to replicate an actual ditching situation and an interior configuration that included tactical control officer / sensor operator / airborne electronic sensor operator stations; a troop seat; a broom closet; forward, centre, and overhead consoles; a map case; a hauldown pedestal; and sonobuoy tubes. In addition, CH124 exits were constructed for the cockpit—upper personnel door, starboard side push-out hatch and cargo door. To ensure an even further level of fidelity, Bohemier added helicopter emergency egress lighting system (HEELS) to later CH124 configurations. These modifications to the original METS™ design increased the capability to test egress sequences that included all four crewmembers exiting through the upper personnel door. It also permitted two crewmembers to conduct cargo-door work, thus improving capability, such as hoisting operations.

Without question, the ability to practice egress tasks that might be experienced in an actual ditching is extremely valuable. Many civilian and military personnel have echoed these same sentiments, and the METS™ is currently the most widely used underwater-egress simulator in the world with 100 models being used in 27 countries.

The latest iteration of the CH124 METS™ configuration includes higher fidelity crew stations, cockpit controls and a flat panel interior. Coupled with a state-of-the-art environmental simulation theatre, the next generation METS™ is capable of replicating some of the worst possible conditions while maintaining a safe level of control.

The next two sections outline the connection made between the MH research and development (R&D) at Survival Systems Limited (SSL) and the global oil and gas industry helicopter transport operations. The first section identifies some of the foundational research used to support a world-recognized standard for helicopter underwater-egress training. These early studies helped lay the framework for all future egress training and simulation design. The first section also identifies some of the more recent research that explicitly examines the training protocols used for emergency breathing systems (EBS) and specific interior cabin configurations. The second section continues to identify the links between the MH community and civilian helicopter overwater operators.

Foundational Underwater Egress Research (1990–1999)

As the fidelity of the METS™ continued to increase, it was apparent that CH124 crewmembers might not be able to hold their breath long enough to egress the helicopter. This was particularly true for situations in which they might be exposed to cold water or they had to egress from a seat that was not adjacent to an emergency exit. Therefore, one of the first research projects directly exploring egress was designed to consider the use of an EBS in the METS™ for an offshore workforce.[9] This study was based on military trials that were used to establish guidelines for the selection of a reliable system. As a follow-up to this project, Bohemier, Chandler and Gills[10] completed a second study to explicitly examine the factors that affect egress for the offshore community. Again, this work was based on knowledge that had been gained during the initial MH egress training programmes.

Given that the limited research focused on understanding egress skills at the time,[11] Brooks, Bohemier and Snelling[12] began to explore the influence of emergency-exit design systems. The purpose of the study was to identify specific egress difficulties associated with the design and use of the exit systems. The research participants for this study were recruited from 12 Wing Shearwater, as they were well-trained and eager to assist in the project. Results from this study were then used to explore similar ergonomic and training issues for a wider range of helicopters, and a secondary study included data from offshore helicopter configurations.[13] Through these initial studies, the direct link between military research and civilian operations, particularly the oil and gas industry, identified the importance of applied research and development. It should be noted that, based on the response and the performance of the MH community participants, many other Sea King crewmembers have been recruited for a number of other research projects.

Following these initial studies, Brooks, Potter, Hognestad and Baranski[14] began to develop life-raft-evacuation procedures for the offshore oil and gas industry. The work was based on previous investigations and anecdotal case studies of ditching events similar to those outlined in Table 1. As noted in the data for Table 1, 6 of the 11 (55 per cent) ditchings resulted in a dry/upright evacuation into a life raft. At the time of the study, only a few offshore helicopters that had ditched were equipped with external flotation devices or hull-shaped fuselages similar to the CH124. The valuable knowledge gained from CH124 crew evacuations aided in the assessment of whether it was better to board the life raft directly from the helicopter (dry-shod) or to enter the water first (swim away) and then board the raft wet.

Recent Underwater Egress Research (2000–2012)

Focus on underwater egress conditions continued in the early part of this century, with research projects exploring emergency exit lighting systems similar to HEELS located at the upper personnel and cargo door in the CH124.[15] The findings indicated that some lighting systems are significantly more detectable in cold turbid water and may aid in the location of emergency exits if personnel become disoriented during egress. As part of the study, an "ultimate emergency helicopter exit" that was being designed in collaboration between SSL and the Department of National Defence was tested alongside conventional lighting systems. Although the complete exit design has not been installed in any actual helicopters, the concept of lighting the functioning mechanism was used in Sikorsky's S92 mechanical exit and handle.

During the latter part of 2000, Brooks, Muir and Gibbs[16] began work on establishing a maximal breath-hold egress time for an offshore transport helicopter. A number of research participants for this study were serving or ex-military members from the MH community. The findings from this particular study have been used in several other projects, and the recommended 20-second breath-hold egress time is considered the standard for deciding whether to include emergency breathing devices into personal protective equipment for flights over water.[17] As an example, Taber and McCabe[18] used the 20-second egress time to recommend the use of an EBS for the Land Force element of the Standing Contingency Force after completing a dry- and wet-snag analysis for the troops that might be transported in a modified CH124. The ability to replicate the interior of the modified CH124 was possible because of the willingness to allow a site visit to 12 Wing before the testing began. 12 Wing members also assisted with the dry-land training process for the troops and offered their personal perspective on egress techniques.

The 20-second egress time has also been used in more recent research that explores egress from a Super Puma interior cabin configuration and the effects of a crash attenuating seat.[19] The crash-attenuating-seat study considers how the displacement of an individual (as a result of a heavy impact) may influence the capability to perform standard egress procedures. The findings indicate that if the individual is displaced during impact force, there are significant increases in difficulty and the time required to complete an egress. These findings have direct relevance for the MH community, as similar seats are used in the new CH148 (Cyclone).

The following section outlines the direct link between the MH community and the development of civilian aviation standards. The section briefly highlights some of the projects that were used to develop testing protocols and standards for a civilian workforce. It should be noted that without the collaborative effort of the people within the MH community, many of the projects would not have taken place.

CH124 Influence

Many of the findings from the early research studies have been implemented into the design of helicopter underwater egress training (HUET) programmes for civilian operations. Specifically, liquid-cooling-garment and immersion-suit requirement work in the mid to late 1980s aided in the development of heat stress and buoyancy guidelines for an offshore helicopter abandonment suit.[20] Although these offshore immersion suits have been modified many times since the original testing, the basic ideas of comfort and functionality have remained as core design factors. For example, when testing the effect of heat stress while wearing an offshore passenger transportation suit, Taber, Dies and Cheung[21] used similar heat exposure protocols that have been used to test the Mustang MSF750 Canadian Forces constant wear aviation drysuit (often referred to as a "Poopy" suit) worn by CH124 aircrew. As further evidence of the link between military and civilian suits designs, the Mustang constant wear suit is often used as a comparison to the offshore transportation suit in classroom discussions about long-term survivability, as it is similar to the immersion suits worn by the civilian pilots who fly the workers to offshore installations.

Another significant connection between MH community equipment and the current offshore programmes is the development of the helicopter underwater emergency breathing apparatus (HUEBA). The HUEBA used for offshore personnel in Atlantic Canada is an LV 2 made by United States Diver / Aqua Lung and is similar to the model used by the Canadian Air Force. Emergency-breathing-system research in the CH124 during the 1980s and early 1990s has led directly to the use of compressed air systems for the oil- and gas-industry workers in Atlantic Canada (the only civilian workforce in the world to use the system at this time). Technical documentation of EBS and nuclear, biological and chemical defence (NBCD) integrations as well as configurations of the life preserver vest, backpack and the CH148 interior have also been used as supporting evidence for the development of egress training procedures.

Future Collaboration and Final Thoughts

The latest version (next generation) of the METS™ has an extremely high physical fidelity contained within the simulation. In fact, the METS™ configurations are now within 0.4 centimetres of the actual helicopter. As SSL and the MH community move forward into new endeavours in safety education, training technologies, applied research and flight platforms, respectively, the long history of collaboration between the two groups will continue to ensure that passengers and flight crew are fully prepared to survive the unthinkable. The MH community should be commended for their support and dedication to the pursuit of safety. Without the professional and expert collaboration between the MH community and the commercial sector, many of these advancements in egress-training procedures that have allowed SSL to become a global leader in saving the lives of aircrew and passengers would not be possible.

Notes

1. Harold R. Booher, *Handbook of Human Systems Integration* (Hoboken, NJ: John Wiley and Sons, Inc., 2003).

2. Brian Northrup, "The Sea King Saga: Attrition by Numbers," *Air Force Magazine* (Winter 2008): 11–15.

3. Based on data from Ibid.

4. George. J. Dufek, *Operation Deepfreeze* (New York: Harcourt, Brace and Company, 1957); J. M. Lillard, "First at Sea: The Earlier Ship Borne Helicopter," *Rotor & Wing* 33, no. 2 (1999): 74; and Michael J. Taber and John McCabe, "An Examination of Survival Rates Based on External Flotation Devices: A Helicopter Ditching Review from 1971 to 2005," *SAFE Journal* 35, no. 1 (2007).

5. Wilfred Kaneb, "Letters: Dilbert Memories," *Popular Science Magazine* (August 1997): 8; and Christopher James Brooks et al., "Civilian Helicopter Accidents into Water: Analysis of 46 Cases 1979–2006," *Aviation, Space, and Environmental Medicine* 79, no. 10 (October 2008).

6. C. J. Brooks, AGARDograph 305(E), *The Human Factors Related to Escape and Survival from Helicopter Ditching Water* (Neuilly sur Seine, France: North Atlantic Treaty Organization Advisory Group for Aerospace Research and Development, 1989).

7. A. Bohemier et al., "High Fidelity Survival Training for Ditched Aircrew and Passengers" (Conference proceedings for the RTO HFM Symposium on Current Aeromedical Issues in Rotary Wing Operations, 1998), 2-1.

8. Ibid.

9. Albert P. Bohemier, A. Chandler, and S. Gill, *Emergency Breathing Systems as an Aid to Egress from a Downed Flooded Helicopter*, COGLA Report No. 108, May 1990.

10. Albert P. Bohemier, A. Chandler, and S. Gill, *Factors Affecting Egress from a Downed Flooded Helicopter*, COGLA Report No. 109, 1991.

11. Charles C. T. Chen, M. Muller, and K. M. Fogarty, *Rotorcraft Ditchings and Water-Related Impacts that Occurred from 1982 to 1989 – Phase 1* (Atlantic City, US Department of Transporation, Federal Aviation Administration, October 1993) Report No. DOT/FAA/CT-92/13; William F. Cunningham, *Helicopter Underwater Escape Trainer (9D5)*, AGARD Conference Proceedings, No. 255 (Operation Helicopter Aviation Medicine), 1978; and John J. Glancy and Stanley P. Desjardins, *A Survey of Naval Aircraft Crash Environments with Emphasis on Structural Response* (Arlington, VA: Office of Naval Research, December 1971) Report No. 1500-71-43.

12. Chris J. Brooks, Albert P. Bohemier, and G. Robert Snelling, "The Ergonomics of Jettisoning Escape Hatches in a Ditched Helicopter," *Aviation, Space, and Environmental Medicine* 65, no. 5 (1994).

13. Chris J. Brooks and Albert P. Bohemier, "Helicopter Door and Window Jettison Mechanisms for Underwater Escape: Ergonomic Confusion!," *Aviation, Space, and Environmental Medicine* 68, no. 9 (1997).

14. Chris J. Brooks et al., "Liferaft Evacuation from a Ditched Helicopter: Dry Shod vs. Swim Away Method," *Aviation, Space, and Environmental Medicine* 68 (1997).

15. Brendan D. O'Neil, John Kozey, and Chris J. Brooks, "Underwater Detectability of a Lighting System on a Helicopter Escape Exit," *Aviation, Space and Environmental Medicine* 75, no. 6 (2004).

16. Chris J. Brooks, Helen C. Muir, and Peter N. A. Gibbs, "The Basis for the Development of a Fuselage Evacuation Time for a Ditched Helicopter," *Aviation, Space, and Environmental Medicine*, 72 (2001).

17. Michael. J. Taber and John McCabe, "The Effect of Emergency Breathing Systems during Helicopter Underwater Escape Training for Land Force Troops," *Safety Science* 47, no 8 (2009).

18. Ibid.

19. Michael. J. Taber, "Instructional Task Analysis of Helicopter Underwater Escape Training in an AS332L Super Puma" (Survival Systems Training Limited, 2007); and Michael J. Taber, "The Effect of Crash Attenuating Seats on Helicopter Underwater Egress Skill Performance" (Survival Systems Limited, 2012).

20. Chris J. Brooks, "Maximum Acceptable Inherent Buoyancy Limit for Aircrew/Passenger Helicopter Immersion Suit Systems," *Applied Ergonomics* 19, no. 4 (1988).

21. Michael J. Taber, Natalie Dies, and Stephen S. Cheung, "The Effect of Transportation Suit Induced Heat Stress on Helicopter Underwater Escape Preparation and Task Performance," *Applied Ergonomics* 42, no. 6 (2011).

Michael J. Taber

Dr. Taber has completed industry-based human factors survivability research for clients such as Department of National Defence, National Research Council of Canada, Exxon Mobil and EnCana Corporation. Dr. Taber holds a bachelor's degree in psychology, a Master of Science in Kinesiology and a Doctoral degree in Interdisciplinary Studies (Psychology, Human Performance and Industrial Engineering). His research focuses on issues of situation awareness, contextual interference, and negative transfer of skills in extreme environments. Dr. Taber currently holds a position as a Post-Doctoral Fellow at Dalhousie University and is the Director of Research and Development at Survival Systems Limited.

Albert Bohemier

Former Canadian Air Force pilot Albert Bohemier founded Survival Systems Limited in 1982 after surviving a helicopter crash while working for a commercial helicopter operator in the remote Labrador, Newfoundland, wilderness in June 1981.

He strongly promoted the establishment of international standards for helicopter underwater escape training for aircrews and passengers, vastly improving the chances for civilian and military personnel to survive ditching accidents.

He worked with local engineers to develop the prototype for the Modular Egress Training Simulator (METS™). Driven by his direction, design and continued investment in human factors research and development, Survival Systems ditching simulators and associated training hardware have reached a state of excellence, with the most recent, new generation METS™/ SmartJib™/ BXGH™/ STST and the Little Bird having been delivered to the United States Army in 2008.

Through global use of its acclaimed METS™, it is estimated that 500,000 students have been trained worldwide, undergoing approximately 3,000,000 training sequences in total.

Survival Systems and Albert Bohemier have received numerous prestigious awards in Canada and abroad, including two Canada Export Awards (1995, 2000); four Provincial Export Awards (1993, 1994, 1998 and 2004); Entrepreneur of the Year (1995); and the Order of Preventionist Merit (1999) from the National Safety Association of Brazil. His most recent honour was having received the Petroleum Pioneer Award from the Offshore/Onshore Technologies Association of Nova Scotia (OTANS) in 2008.

Survival Systems has a single stated purpose: To "enhance and preserve workers' lives through safety education, training technologies, and applied research and development."

Chapter 11

Operation BRIDGE: A Bold Leap Towards the Cyclone

Sam Michaud

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The recognition that things that are not sustainable will eventually come to an end does not give us much of a guide to whether the transition will be calm or exciting.[1]

Timothy Geithner

By 2008, the maritime helicopter (MH) community in 12 Wing[2] was still very much trying to reset itself following the herculean efforts of Operation (Op) APOLLO, which saw the MH community deploy its helicopter air detachments (HELAIRDETs) repeatedly for long back-to-back deployments in the months following 9/11. This tremendous surge effort, an essential part of Canada's contribution to the global war on terrorism, resulted in a dip in flying rates and a resultant reduction in the rates of aircrew and technician force generation (FG) in the wake of the deployments. The community hit its nadir in February 2006 when the loss of Sea King CH12438 placed a spotlight on the residual, deleterious effects of the low flying rates on pilot proficiency and community morale.

At the same time, the broader Air Force was facing the demographic effects of the force reduction programmes (FRP)[3] of the 1990s, which had seriously reduced the cadre of experienced aircrew and technicians available to line units as operational tempos remained at record high rates. Set against a tableau of rapid fleet renewals and large investments across the Air Force, there was a clear imperative to focus intensely on the FG of new personnel to maintain operational capacity and to be ready to introduce new aircraft as they arrived in service.

The challenge of introducing a new aircraft into service in the MH community was seen to be greatly exacerbated by the multigenerational leap in technology that the CH148 Cyclone would represent in relation to the Sea King. While the Sea King continued to provide yeoman service—thanks in large part to the often heroic efforts of its technicians and support personnel—the clear reality was that it was functionally obsolete for any modern maritime warfare tasks. As well, the lack of technology investment in the past decade meant that the Sea King's avionics simply did not provide a sufficiently advanced platform to prepare crews for the demands of a 21st-century weapon platform. Remembering that the Sea King entered service at the same time as the CF104 Starfighter, the jump from Sea King to Cyclone would be analogous to a jump from the Starfighter to the F-35 Joint Strike Fighter—without the benefit of the CF188 Hornet as an intermediary.

While the efforts of the community in implementing Project Transform[4] were yielding tangible improvements to aircraft availability and flying rates, it was obvious that a change of vector would be needed if the community was to be ready for the arrival of the Cyclone while also meeting the operational demands of the day. Given this stark outlook, the Wing Commander, Colonel Bruce Ploughman, signed an initiating directive in June 2008 to begin work on what would become known as Op BRIDGE. The directive set in motion work to develop a plan that would position the MH community to support the overall Air Force pilot production goals, maintain (or develop) relevant transitional operational capability and capacity in the CH124, and set the conditions for rapid transition to the CH148.[5]

A planning team was assembled; its members were drawn from all units in 12 Wing and placed under the leadership of the Wing Chief of Staff, Lieutenant-Colonel Jeff Tasseron. The team was given several months to address the challenge and tasked to fulfill five key goals:[6]

- optimize 12 Wing FG capacity to increase the overall generation and absorption of MH pilots[7] by a minimum of 50 per cent by reducing or eliminating all non-value added demands that limit or constrain Sea King FG;
- define a "twilight" concept of operations (CONOPS) to align Sea King capabilities to meet known and emergent operational demands through the development of key new capabilities that will optimize the Sea King's utility as an intelligence, surveillance and reconnaissance (ISR) platform and the temporary de-emphasis of extant low-probability, high-demand tasks such as antisubmarine warfare (ASW);
- optimize Sea King aircrew training and currency requirements to meet the immediate force employment needs established by higher headquarters, and implied by the twilight CONOPS, while accepting risk in areas that have been identified for de-emphasis through the bridging period while ensuring that core MH skill sets are preserved;
- increase Sea King yearly flying rate (YFR) production, as required, to meet the demands of the plan; and
- maintain core MH skill sets and competencies.[8]

One of the early difficulties encountered in the analysis was the development of a transitional—or twilight—CONOPS for the Sea King that would define a meaningful end-of-life role for the Sea King that was realistic, attainable and useful. The tension that emerged resulted less from a lack of resources than it did from a debate over how much of the Sea King's traditional ASW role could be depreciated to offset investments into other non-traditional mission areas. The debate was not, as some might expect, a Manichaean black and white disagreement between the traditionalists who saw ASW as sacrosanct and the post–cold war reformists who believed that ASW was no longer relevant in a post-9/11 world. Indeed, there was broad agreement that—irrespective of one's views on the relevance or likelihood of the ASW fight in the new world order—the Sea King's mission systems were simply no longer combat effective for the demands of a modern ASW war. The real debate centred on whether it was necessary to maintain the ASW mission set as a high-demand mission set to act as a crucible that would gel MH crews into the highly effective, and mission-flexible, crews that had carried the community so far.

Following lengthy debate and analysis, it was accepted that there was a very real need to maintain the ability to train MH crews to operate in high-demand, dynamic and information-rich mission sets. When set across the foreseen operational demands of the coming years, it became obvious that something other than traditional ASW needed to be developed to provide this training while also being more relevant to the pressing operational challenges facing the community. The debate also generated one of the most powerful insights of the Op BRIDGE analysis: the understanding that the Sea King itself would be the most important transitional tool available to prepare the community for the Cyclone. Therefore, as an adjunct to the immediate operational needs, the new mission focus had to be carefully conceived to better prepare crews for the highly integrated, sensor-rich, mission systems coming in the Cyclone.

In considering the option space available for a new twilight focus, the mission analysis first had to consider the full spectrum of missions that could be assigned to a generic MH platform and then focus in on what was core to the MH community and what was relevant to the demands and imperatives of the coming years—not least of which were the expectations of the Canadian government as articulated in the release of the *Canada First* Defence Strategy (*CFDS*).[9] The broad results of this analysis are shown in Figure 1, which graphically represents a subtle but significant shift away from high-readiness ASW operations towards an ISR mission set that was in greater demand for ongoing real-world missions and operations like Op PODIUM—the 2010 Vancouver Winter Olympics—that were on the immediate horizon. In practice, this approach did not advocate for a complete abandonment of ASW training, nor did it imply that ASW was no longer relevant, it merely argued for a more sensible balance of priorities given the realities of the day—a shift towards General Hillier's metaphorical "ball of snakes" and away from "the bear."[10]

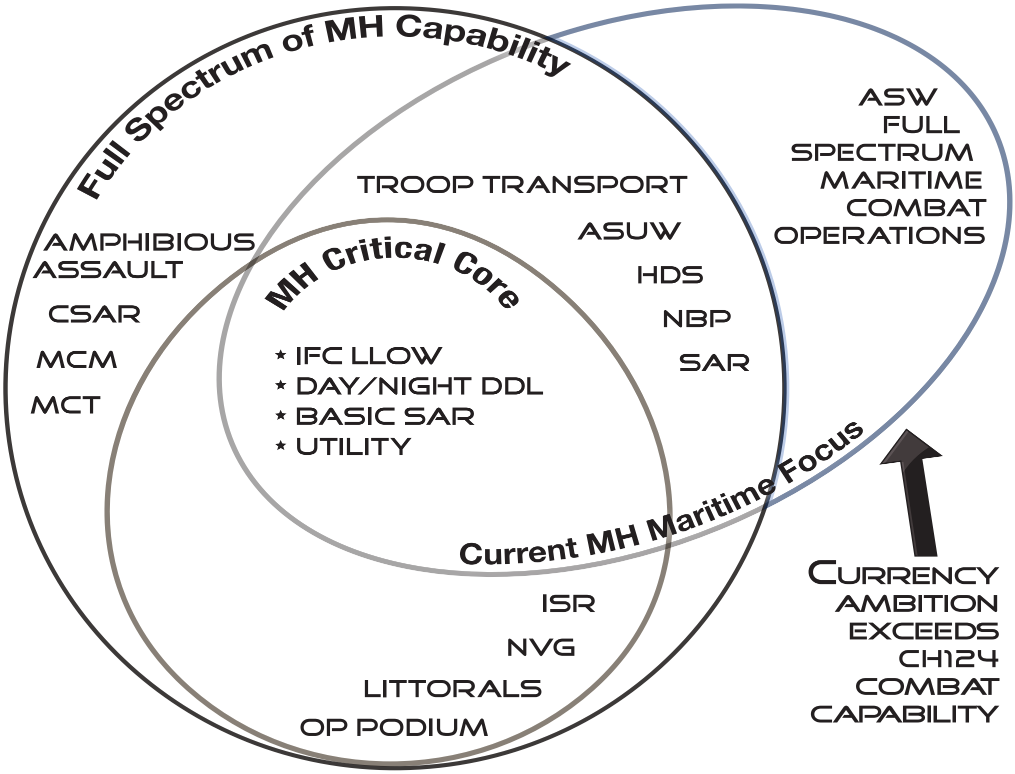

Figure 1. Rebalancing MH capability.

The mission analysis also brought clarity to what would be defined as the critical MH core—those capabilities without which the community would no longer be seen as a credible MH capability. It was agreed that, once defined, the core would represent the vital ground of the community's competencies that would be defended from all resource pressures or externally imposed expediencies. While the core capabilities were deliberately constrained to what appears to be a superficially simple list, the core concept was a powerful tool in defending the community's critical competencies when faced with external pressures to adopt simple solutions to complex problems. This was evident in the later fight to sustain core sea time when operational demands for overland mission sets peaked during Ops PODIUM and CADENCE.[11] As finally defined in the Op BRIDGE order, the MH core mission set was defined as the ability to:

- operate day or night in either visual or instrument meteorological conditions (VMC or IMC) embarked upon HMC [Her Majesty's Canadian] Ships or in the overland littoral environment;
- operate day or night in either VMC or IMC in the low level over water (LLOW) environment, including transition to the coupled hover;
- manage operational duties and perform on-board sensor fusion in the dynamic small crew context;
- perform basic utility and logistical support, including slinging and hosting, either embarked or ashore; and
- perform basic organic SAR [search and rescue] functions, either embarked or ashore.[12]

By the end of the summer of 2008 and with the key debates largely resolved, a draft plan and decision brief were ready for final Wing Commander approval and sign off. Despite the intensity and passion of some of the earlier debates, by the time of the final decision brief, a strong, pervasive consensus had been achieved among the core 12 Wing command staff, and there was unanimous acceptance of the three key driving factors identified in BRIDGE that made immediate action imperative:

- the need to dramatically increase the force generation (FG) of aircrew and technical and support personnel to address the looming demographic hole, and to meet the challenge of rapid fleet renewal across the air force;

- the imperative to meet operational force employment (FE) demands in an adaptable and evolving operating environment … in the final years of the CH124 Sea King's operational life; and

- the requirement to transition quickly and effectively to the new CH148 Cyclone when it arrives.[13]

It is important to note that the earlier pilot centricity of the Operation BRIDGE initiating directive had given way under the weight of the analysis that showed that a complex balance of personnel FG was necessary to sustain a meaningful deployable capability. This nuanced understanding of a complex problem space later led to important decisions—like the decision to remove an airworthy Sea King from flight operations to dedicate the airframe for technician force generation—that would not have been manifestly evident if the focus had remained on pilot FG. Indeed, in the face of unrelenting pressure from the Air Force senior leadership to focus solely on pilot training, the Op BRIDGE analysis gave the MH leadership the understanding of the importance of ensuring equal care and attention was given to all MH FG efforts to achieve an effective and sustainable operational output.[14]

Op BRIDGE focussed the wing's efforts along four main thrust lines: purpose, people, plane and processes. Within each of the thrust lines, a set of defined activities and measurable goals were directed. While delving into the specifics of each task and goal is beyond the scope of this paper, the key parts of each thrust are described below:

a. **Purpose**. For much of its operational history, the MH community has defined itself based on the needs and operational imperatives of general maritime warfare. However, as the [Sea King] operational mission suite has drifted into obsolescence, [the ability of the Sea King] to contribute meaningfully in the high-end arena of ASW has diminished at the same time as the probability of our participation in such roles has lessened. As well, there has been a growing understanding that the most valuable knowledge transfer between the [Sea King] and the [Cyclone] is not in the realm of traditional operational capabilities[15] but rather in the operational skill sets that comprise core MH competencies. Therefore, while still operating with the defined boundaries of the approved MH CONOPS,[16] … the MH community will focus on a "Twilight" CONOPS for the [Sea King] that is broadly defined by a decreased focus on high-cost, low-demand capabilities to enable a shift towards the low-cost, high-demand, high-impact capabilities that characterize our contemporary operational environment.[17]

b. **People.** To build and sustain a "qualitatively superior and quantitatively sufficient cadre of operationally focussed aircrew, technical, and support personnel,"[18] the MH community would increase production of CH124 pilots from 12 per year in 2008 to 16 per year in 2009 while maintaining a balance in the production of other aircrew and technical occupations. It was also directed that the outflow of MH technicians would be stabilized[19] "to permit the maintenance of a minimum of 80 percent POM (performance of maintenance) [qualified technicians] at the operational squadrons."[20]

c. **Plane.** Despite its advanced age and the obsolescence of many of its mission systems, the [Sea King] remains one of the most operationally employed combat platforms in the CF. … Success in its final years of service will be defined by not only the contribution of the

CH124 to the operational success of the MH community but also by its effectiveness as a key transitional tool. [Among the primary initiatives directed in this thrust were the directives to]:

1. identify and remove high-maintenance, obsolete mission systems, including the AN/AQS-13 SONAR,[21] from the aircraft to enhance the sustainability of the CH124;

2. assess and recommend modest ISR mission capability enhancements[22] which are relatively low-cost, low-risk, and high return-on-investment …; and

3. introduce a night vision goggle (NVG) capability[23] to reduce operational risk … and to accelerate CH148 transition.[24]

d. **Processes.** Intended to build upon the initiatives and lessons of Project Transform, BRIDGE directed the implementation of a series of initiatives best described as a continuous improvement effort designed to shift the culture of the community irrevocably into a lean and innovative mindset similar to the one that had defined the early years of the community.

The initial reception to the release of Op BRIDGE was decidedly mixed and was largely due, in hindsight, to the failure of the wing's leadership to fully appreciate how disruptive the initiatives would be seen to be to entrenched interests. Some senior leaders jumped quickly to erroneous conclusions[25] about the intent of Op BRIDGE and accused the community of "going rogue" by redefining its mission without higher authorization to do so. In reality, this visceral reaction was mostly due to a lack of prebriefing the senior leadership of both the Air Force and Navy to ensure that the full intentions were clear and seen to be respecting approved lines of authority. Despite the initially turbulent reception from above, once the misconceptions had been addressed and the wing leadership chastised for stepping out too far in front of its mandate, the general impression received back from informal feedback appeared to be overwhelmingly positive. Not only was the need for immediate and transformative change recognized, the general approach of BRIDGE was seen to offer insights that could be useful to the challenges facing the broader Air Force. In particular, the need to review self-imposed regulations to see what inefficiencies could be removed was embraced by the operational leadership of the Air Force.

Within the MH community, the reception was far more positive, largely due to the broad engagement early on in the analysis and a more visceral understanding of the immediate challenges facing the wing. While not everyone agreed with every element of the direction, the broad thrusts were easily accepted, and the clear, specific nature of the direction contained in the operation order left little doubt as to what was expected. Certainly, many saw the directive as both an opportunity to push for reform and a call to arms to implement innovative solutions. Nowhere was this latter enthusiasm more evident than in the Augmented Surface Picture (ASP) initiative spearheaded by a small team led by Majors Dwight Bazinet and Josiah Goodyear, plus Captain Kel Jeffries.

The ASP story has been well documented elsewhere, so it is not this paper's intent to revisit this story of stunning technical innovation, grass-roots leadership and personal perseverance. What is important in this context is to understand that the conditions required for ASP to move forward with unequivocal leadership support and endorsement were forged in the Op BRIDGE directive. It was the understanding that the MH community needed to shift away from its traditional focus on general maritime warfare and focus instead on the "low-cost, high-demand, high-impact capabilities that characterize our contemporary operational environment."[26] This core shift in purpose—which underpinned the general philosophy of Op BRIDGE and led to the specific direction under the third thrust line (Plane) to investigate "modest ISR mission capability enhancements which are relatively low-cost, low-risk, and high return-on-investment"[27]—was the direct organizational genesis for ASP. Given the commitment of the ASP core team, the assistance of supporting agencies and the supporting context provided by BRIDGE, it is still impressive to note that the team achieved first flight on a brand-new integrated ISR mission system in October 2009, barely a year after the signing of the Op BRIDGE operation order. ASP remains one of the most tangible and lasting successes that resulted from BRIDGE and, at the time of this writing, is in high operational demand in the fleet and continues to benefit from ongoing development.

An equally important capability investment was the introduction of NVGs to the Sea King. While NVGs had first been flown on the Sea King in the early 1990s as part of Op FRICTION (the Canadian contribution to the first Gulf War), the lack of an NVG-compatible cockpit meant the use of NVGs was limited to back-end crew. This effectively left the pilots flying "blind" at night and reliant solely on the flight instruments to keep the aircraft out of danger. Adding the capability to the Sea King was not as simple as strapping goggles to the pilots' helmets—indeed, the undertaking was complex enough that previous efforts had repeatedly fallen short. The reasons that the previous initiatives had failed are complex, but one of the key missing pieces was always the lack of a clear reasoning for the initiative to give it the foundation necessary to overcome institutional inertia. After all, the Sea King had operated just fine for over four decades without NVGs, so many questioned the need to make the investment with the Sea King's retirement "imminent."[28]

Op BRIDGE provided the needed foundation by offering two key reasons to answer the question "why now?" and to provide the logic that explained the value of the return on invested capital. First, the mission sets that were increasingly becoming part of the Sea King's routine tasks involved more and more overland flying. Without NVGs in the overland environment, the aircraft's mission effectiveness became extremely limited at night, as it was almost impossible to operate safely in the low-level flight environment when the pilots could not see and avoid obstacles. The second reason was that the Sea King provided the perfect introductory vehicle for NVG training in advance of the Cyclone. Rather than have pilots grapple with the tasks associated with flying and fighting a brand new aircraft while also developing the procedures to operate in the MH environment, it was seen as prudent to "pull forward" the requirement to learn and develop these skills in a familiar aircraft. Doing so would not only reduce the overall risk of the training but also reduce the transition time to the Cyclone when it arrived.

The project to convert the Sea King fleet to be fully NVG compatible was an enormous success. A prototype configuration was designed, installed and tested in rapid order thanks to a cooperative effort from units across the CF. The clear prioritization of the effort by Air Force leadership and the lack of equivocation from the MH community on the importance of the capability were key drivers to the rapid implementation and flowed naturally from the vision established in the Op BRIDGE directive. By early 2011, training of operational pilots had begun in earnest, and the success of the project could be measured by the extreme reluctance of NVG-qualified pilots to fly at night without goggles[29] once they had flown with them. At the time of writing, the conversion of the MH community to NVGs had been successfully completed without significant incident.

As time passes since the initiation of Op BRIDGE, the vision it laid out remains a powerful influence in the MH community, even as its very name slowly fades into disuse. While two of the most visible and obvious projects that derived from BRIDGE have been used here to highlight the potency of its powerful vision and clear direction, the changes in the MH community stemming from BRIDGE have been legion. Indeed, while it is still too early to definitively declare Op BRIDGE a success, the most significant and lasting effects will likely be found in the cultural shift that it enabled more so than the physical artefacts introduced through a series of connected initiatives. The final word on BRIDGE will be written[30] after the Cyclone has been successfully introduced to service and the Sea King paid off from military employment. But what can be declared without hesitation is that the MH community is far better positioned to face the concatenated challenges of operating in the messy milieu of today's contemporary operating environment and making the multigenerational technological leap into the Cyclone when it is finally ready to fill the Sea King's shoes.

Annex A

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Shearwater NS B0J 3A0

3000-1 (W Comd)

23 September 2008

Distribution List

12 WING OPERATION ORDER 010/08
OPERATION BRIDGE – 12 WING TRANSITION

References: A. Canada First Defence Strategy
B. 1 CAD HQ 3255-4 (A3 MH RDNS) 20 March 2001
C. Commander's Force Generation Plan

SITUATION

1. 12 Wing must position itself for success as the Maritime Helicopter (MH) community faces its most significant challenges in the closing years of CH124 Sea King operations. While OP TRANSFORM was successful in re-establishing a sustainable foundation for MH operations, it is no longer sufficient to meet the demands and expectations of force generators and employers or prepare the MH community for the demands of transition. Three key factors support the need for 12 Wing to act now:

a. the need to dramatically increase force generation (FG) of aircrew and technical and support personnel to address the looming demographic hole, and to meet the challenge of rapid fleet renewal across the air force;
b. the imperative to meet operational force employment (FE) demands in an adaptable and evolving operating environment, including OP PODIUM (the 2010 Winter Olympics), in the final years of the CH124 Sea King's operational life; and
c. the requirement to transition quickly and effectively to the new CH148 Cyclone when it arrives.

2. From a FG perspective, the air force is entering into a period of unprecedented opportunity and challenge. *A weak demographic profile, resulting in higher than normal attrition rates, will leave the air force vulnerable up to and possibly beyond the next five years*. Coupled with the broad-based rapid renewal of the air force's key operational fleets, an intense focus on the FG of new air force personnel is critical. At the leading edge of these FG demands, 12 Wing has been tasked to substantially increase its production of new aircrew and technical personnel. Although specific demands for the FG of new pilots have already been identified by the air force, 12 Wing understands the need to balance FG across all occupations and must ensure equal care and attention is given to all Wing FG efforts to achieve an effective operational output.

3. Since the end of the Cold War, the MH community has seen operational demand increase steadily. At the same time, the operational environment has shifted away from state-on-state conflict, the "bears" of the former CDS' vision, to a complex of non-traditional warfare areas and security challenges, the "ball of snakes." In keeping with government direction, at reference A, 12 Wing will focus on aligning MH readiness to the real-world security needs of Canadians, while de-emphasizing readiness in low probability areas. In particular, this means aligning CH124 readiness and training to meet the needs of contemporary operations in the defence of Canada, the North American continent, and ongoing operations in the international war on terror.

4. Finally, the MH community cannot wait until the CH148 Cyclone arrives to shift into full transition. The Sea King is one of the most important enablers of transition and must be used to its full potential in its twilight years to help generate the right people, the right ideas, and the right processes necessary for success in our future operations. Transitioning as quickly and effectively as possible to the Cyclone is critical, not only because of the world-leading operational capabilities it possesses, but also because of the dramatically more robust FG capacity that is inherent in the new training system.

MISSION

5. 12 Wing will refocus MH operational capability from general maritime warfare to specialize on the multi-mission ISR and the general utility requirement of a joint force, medium-lift helicopter, while protecting the core MH skill sets to meet FG demands, evolving FE imperatives, and enable transition.

EXECUTION

6. Commander's Intent. Broad goals for this plan are to:

a. increase 12 Wing FG capacity to meet higher headquarters (HHQ) direction. Overall generation and absorption of MH pilots must increase by a minimum of 50 percent by reducing or eliminating all non-value added demands that limit or constrain CH124 FG. All other Wing FG activities will be aligned to support and sustain the achievement of this goal while also maintaining clear balance in FG across all MH community occupations;
b. focus CH124 operations on a "Twilight" CONOPs by aligning CH124 capabilities to meet known and emergent operational demands that will optimize the CH124's utilization as an ISR platform while accepting a temporary lower readiness state for the low probability, high demand task of anti-submarine warfare (ASW);
c. minimize CH124 training and currency requirements by conducting only training required to meet the immediate FE needs established by HHQ, while accepting risk in areas that have been identified for de-emphasis through the bridging period;
d. increase CH124 YFR production, as required, to meet the demands of the plan;
e. transition to the end-state CH148 processes, structures, and infrastructure as early as practicable; and
f. protect and maintain core MH skill sets and competencies. The core MH competencies are defined as the ability to:

(1) operate day or night in either visual or instrument meteorological conditions (VMC or IMC) embarked upon HMC Ships or in the overland littoral environment;

(2) operate day or night in either VMC or IMC in the low level over water (LLOW) environment, including transition to the coupled hover;

(3) manage operational duties and perform on-board sensor fusion in the dynamic small crew context;

(4) perform basic utility and logistical support, including slinging and hoisting, either embarked or ashore; and

(5) perform basic organic SAR functions, either embarked or ashore.

7. Concept of Operations. 12 Wing OP BRIDGE activities will be organized along four main thrust lines: Purpose, People, Plane, and Processes. The key objectives of each of these "4Ps" are outlined below with the detailed plans contained in the coordinating annexes attached to this plan:

a. Purpose. For much of its operational history, the MH community has defined itself based on the needs and operational imperatives of general maritime warfare. However, as the CH124 operational mission suite has drifted into obsolescence, our ability to contribute meaningfully in the high-end arena of ASW has diminished at the same time as the probability of our participation in such roles has lessened. As well, there has been a growing understanding that the most valuable knowledge transfer between the CH124 and the CH148 is not in the realm of the traditional operational capabilities but rather in the operational skill sets that comprise core MH competencies. Therefore, while still operating within the defined boundaries of the approved MH CONOPs, defined at reference B, the MH community will focus on a "Twilight" CONOPs for the CH124 that is broadly defined by a decreased focus on high-cost, low-demand capabilities to enable a shift towards the low-cost, high-demand, high-impact capabilities that characterize our contemporary operational environment. More specifically, this means:

(1) a decreased readiness state for ASW operations. The MH community will reduce its posture for ASW operations to a readiness state that allows for 180 days to regenerate an operational ASW capability. All specific OTU production and operational crew training for ASW missions will cease and only a cadre level of expertise will be maintained through the use of simulation;

(2) an increased focus on ISR operations. The MH community will pursue limited enhancements to its ISR capabilities from the perspective of equipment, doctrine, and training; and

(3) an alignment and/or enhancement of MH training and readiness activities to meet the anticipated operational demands of domestic contingencies OP PODIUM and support to ongoing Navy missions.

b. People. It is essential that 12 Wing build and sustain a qualitatively superior and quantitatively sufficient cadre of operationally focussed aircrew, technical, and support personnel. To do so, 12 Wing must:

(1) increase production of ab initio CH124 pilots to 12 per year in 2008/2009 and 16 in 2009/2010, while ensuring that an appropriate balance is maintained in the production of other aircrew and technical occupations to produce a sustainable MH capability;

(2) rationalize aircrew qualifications and upgrade processes to better reflect the demands of the community to better support current and future operations.

(3) increase operational squadron personnel absorption capacity to match training unit output, as well as streamline upgrade processes to ensure that pilots reach MHC within 24 months of completion of training; and

(4) stabilize MH technician outflows due to postings and incremental taskings while increasing throughput to permit the maintenance of a minimum of 80 percent POM (performance of maintenance) qualification at the operational squadrons.

c. Plane. Despite its advanced age and the obsolescence of many of its mission systems, the CH124 remains one of the most operationally employed combat platforms in the CF. In the current and emerging operational environment, the CH124 still offers unique potential in a number of specific roles that cannot be effectively filled by any other CF platform. Success in its final years of service will be defined by not only the contribution of the CH124 to the operational success of the MH community but also by its effectiveness as a key transitional tool. 12 Wing will:

(1) identify and remove high-maintenance, obsolete mission systems, including the AN/AQS-13 SONAR, from the aircraft to enhance the sustainability of the CH124;

(2) identify and improve capabilities that support current operational requirements that enhance transition;

(3) assess and recommend modest ISR mission capability enhancements, which are relatively low-cost, low-risk, and high return-on-investment, to meet operational demand for specific capabilities. As well, conduct a vulnerability assessment of existing aircraft systems to identify potential risk areas and cost-effective modernization options; and

(4) introduce a night vision goggle (NVG) capability to reduce operational risk in current mission profiles and to accelerate CH148 transition.

d. <u>Processes</u>. Building upon the lessons of OP TRANSFORM, the MH community will continue to streamline, rationalize, and amend processes and regulations to improve the efficiency of its operations while developing a more risk tolerant operational environment. As well, to expedite the transition to the CH148, 12 Wing will begin to adopt the new processes, structures, and infrastructure associated with the introduction of the Cyclone as early as practicable. To reduce the parasitic drag of non-value added processes and to prepare the MH community for the transition to the CH148, 12 Wing will:

(1) rationalize and reduce currency and training requirements of all personnel to reflect the CONOPS operational focus, aircraft system, and to meet essential twilight mission requirements;

(2) review and identify training demands imposed by outside agencies that offer limited value added to MH operations or that represent parasitic drag;

(3) begin to realign the Wing organization to reflect the anticipated CH148 organizational end-state; and

(4) develop initial Wing modelling and simulation (M&S) as well as ISR CONOPS to guide development and transitional activities.

8. <u>End-State</u>. OP BRIDGE end-state will occur with the successful phase-out of the CH124 and the achievement of an initial operational capability with the CH148.

<u>SERVICE SUPPORT</u>

9. TBD.

<u>ENVIRONMENTAL IMPACT</u>

10. No environmental impact is anticipated.

COMMAND AND SIGNALS

11. The W Comd will maintain overall command and accountability for the execution of OP BRIDGE. Responsibility for day-to-day coordination and execution of the plan will rest with the 12 Wing Chief of Staff (COS).

[original signed by]

J. B. Ploughman
Colonel
Wing Commander

Annexes
Annex A Purpose Thrust: Coordinating Instructions (TBD)
Annex B People Thrust: Coordinating Instructions (TBD)
Annex C Plane Thrust: Coordinating Instructions (TBD)
Annex D Process Thrust: Coordinating Instructions (TBD)
Annex E Synchronization Matrix (TBD)

Distribution List

Action

12 Wing HQ Shearwater/COS

Information

1 Cdn Air Div HQ Winnipeg/Comd
MARLANTHQ Halifax/Comd
MARPACHQ Esquimalt/Comd
1 Cdn Air Division HQ Det Halifax/Comd
1 Cdn Air Div HQ Det Esquimalt/Comd

Notes

1. Timothy Geithner, BrainyQuote.com, http://www.brainyquote.com/quotes/quotes/t/timothygei409306.html (accessed June 18, 2013).

2. 12 Wing is the operational formation responsible for all MH operations in Canada and has units located in Shearwater, Nova Scotia, and Patricia Bay, British Columbia. At the time of the article's writing there remained 27 of the original 41 Sea Kings in operational service with the majority of them based on the East Coast in Shearwater.

3. The FRPs of 1992 and 1993–96 saw almost 14,000 Regular Force Canadian Forces (CF) personnel take early retirement as part of a series of initiatives to reduce the size of the CF at the end of the cold war. For more information see Chief of Review Services Director General Audit, 7055-29 (DGA), January 1997, Audit of Force Reduction Program.

4. Project Transform, an Air Force-wide initiative, was implemented at 12 Wing in 2003; its aim was to develop long-term options for viable and sustainable capabilities for each Air Force fleet / warfare community. In the context of the Sea King fleet, this initiative was complicated by a number of issues, including inadequate manning, budget cuts, reduced yearly flying rate (YFR), rising fuel costs and a continued high operational tempo. 12 Wing had a flat organization structure with an inadequate wing staff structure and was, therefore, unable to actively manage the above issues. In very broad terms, Project Transform highlighted the need for a robust FG capability (aircrew and technicians) that effectively balanced force employment and FG demands. The plan produced by 12 Wing was well-received by the Air Force, who saw the wing embrace the tenets of Project Transform. The indelible impression left by 12 Wing was one of proactive management and taking charge of their destiny "within means and capabilities." The unforeseen benefit of this shift in higher headquarters

perspective was that future 12 Wing requests for support were better received within the Air Force. Project Transform eventually started to bear out the predicted increases in YFR and, by extension, aircrew FG, thereby setting the conditions for Op BRIDGE.

5. 3000-1 (W Comd), 23 September 2008, 12 Wing Operation Order 010/08 Operation BRIDGE – 12 Wing Transition, paragraph 1.

6. Ibid., paragraph 6

7. The intent of Op BRIDGE was not to be pilot centric, but the implicit assumption was the pilot FG was the "long pole" in the FG tent and any success in reducing impediments to pilot FG would be reflected in improvements throughout the wing's FG process. In practice, it became evident that this was a good starting point for analysis but was insufficient to address all challenges particularly when it came to technician FG and the need to think more broadly was accepted by the time Op BRIDGE was ordered into implementation.

8. What constituted "core MH skill sets and competencies" had never been defined and became one of the implied tasks of Op BRIDGE. An earlier attempt in 1994 to define a core and modular approach to currency and readiness had failed to achieve consensus and was never implemented. In the Op BRIDGE analysis, achieving consensus on the core took many months of discussion and was ultimately resolved at the 12 Wing command level through round-table discussion with the senior leadership of the wing.

9. The *CFDS* was a combined defence policy statement and procurement plan announced by Prime Minister Harper in May 2008. Initially released simply as a declaration, it was eventually formalized into a document that expanded on the principles announced by the Prime Minister. The *CFDS* is available at http://www.forces.gc.ca/site/pri/first-premier/index-eng.asp?WT.svl=CFDLEFT (accessed on June 18, 2013).

10. General Hillier, "Setting Our Course" (speech, CISS Seminar: Implementing Canada's Defence Policy Statement, Royal Canadian Military Institute, July 22, 2005) as cited in Philip S. E. Farrell "Control Theory Perspective of Effects-Based Thinking and Operations: Modelling 'Operations' as a Feedback Control System," Technical Report 2007-168 (Ottawa: Defence R&D Canada, November 2007) http://cradpdf.drdc-rddc.gc.ca/PDFS/unc95/p528512_A1b.pdf (accessed June 18, 2013).

11. Op CADENCE was the 2010 CF mission to provide security for the G8 and G20 summits being held in Ontario.

12. 3000-1 (W Comd), 23 September 2008, 12 Wing Operation Order 010/08 Operation BRIDGE – 12 Wing Transition, paragraph 6 f.

13. Ibid., paragraph 1.

14. Ibid., paragraph 2.

15. As the mission suite of the Cyclone took form, there was a growing understanding that the new sensor suite brought with it such a quantum leap in capability that traditional tactics and approaches to ASW being used in the Sea King would have little or no relevance in the Cyclone. Therefore, it was the general thinking, problem solving and crew coordination skills that were most valuable to the transfer, not the specific application of tactics.

16. 1 CAD HQ 3255-4 (A3 MH RDNS), 20 March 2001, CH124 Sea King Concept of Operations, (note that the last approval of the Sea King CONOPS predates the historic events of 9/11).

17. 3000-1 (W Comd), 23 September 2008, 12 Wing Operation Order 010/08 Operation BRIDGE – 12 Wing Transition, paragraph 7 a. This subparagraph is seminal to the understanding of the core pivot articulated in the Operation BRIDGE operation order.

18. Ibid., paragraph 7 b.

19. In retrospect, it was naive to expect that the MH community would have authority over or would be able to influence the posting priorities for 500-series technicians when other, more influential, communities were hemorrhaging experienced technicians to industry. But it is instructive to note the specific and measurable nature of the goal, a characteristic that defined the overall approach to Op BRIDGE.

20. Ibid., paragraph 7 b (4).

21. Ibid., paragraph 7 c (1). Note that the directive to remove the SONAR from the aircraft was not implemented due to higher headquarters direction to maintain at least the external perception that ASW continued to be strongly supported by the air force.

22. This direction became the initiating direction that led to the development of ASP—an innovative, home grown, integrated mission computer—described later in this paper.

23. Following decades of abortive attempts to introduce NVGs to the Sea King, this initiative was successful with the introduction to service beginning in 2010.

24. Ibid., paragraph 7 c.

25. It didn't help that the West Coast fleet was in the process of preparing a high-readiness ship to join an American task group for a series of ASW exercises and the Op BRIDGE directive was seen to be a direct challenge to their path to high readiness. It was only after a personal briefing by the Wing Commander to the West Coast leadership that tensions eased when it was clear that the wing was still committed to providing a high-readiness ASW HELAIRDET for the deployment. However, this incident put to rest any intention of removing the SONARs from the Sea King fleet to avoid triggering any further sensitivities.

26. Ibid., paragraph 7 a.

27. Ibid., paragraph 7 c (3).

28. The "imminence" of the Sea King's retirement has long been a tired joke in the MH community. It has also been used as an excuse to avoid making substantial capability enhancements to the aircraft for almost two decades.

29. In the early days of NVG conversion training, it was sometimes necessary to task an NVG-qualified pilot to fly a mission with a non-NVG-qualified pilot. By explicit policy, if one pilot was not qualified on NVGs the crew had to default to the lowest common denominator and fly without NVGs. Flying a "mixed" cockpit, with pilots relying on widely different references, had proven to be a dangerous combination in other communities, and the MH community elected to implement this lesson learned from others.

30. The "end-state" defined in the Op BRIDGE order is said to occur "with the successful phase-out of the CH124 and the achievement of an initial operational capability with the CH148." Ibid., paragraph 8.

Sam Michaud

Colonel Sam Michaud (Retired) joined the Canadian Forces (CF) in June 1986 as a Primary Reserve infantry soldier with the West Nova Scotia Regiment. He transferred to the Regular Force in December 1987 to begin training as an officer and a pilot. Upon completion of training, he was posted to Shearwater, Nova Scotia, to complete conversion training on the CH124 Sea King. Through his career, Colonel Michaud (Retired) served multiple tours on the Sea King as an operational pilot, instructor pilot, standards officer, detachment commander as well as enduring three tours in National Defence Headquarters, where he served as a staff officer in various positions related to joint force development. His career highlights include deployments to the first Gulf War and Somalia as well as command of 423 Squadron and 12 Wing Shearwater. He retired from the CF in February 2013 to pursue a second career in the defence industry.

List of Abbreviations

°	degrees
1 CAD	1 Canadian Air Division
1 Cdn Air Div	1 Canadian Air Division
10 TAG	10 Tactical Air Group
9/11	1 September 2001
A/C, a/c	aircraft
A/S	antisubmarine
A3 MH RDNS	A3 Maritime Helicopter Readiness
AAW	anti-air warfare
ACNS(A&W)	Assistant Chief of the Naval Staff (Air & Warfare)
ADAC	Acoustic Data Analysis Centre
ADM(Mat)	Assistant Deputy Minister (Materiel)
AESOP	airborne electronic sensor operator
AETE	Aerospace Engineering Test Establishment
AHR	annual historical report
AIRCOM	Air Command
AMAF	Aircraft Modification Approval Form
AMDU	Aerospace Maintenance Development Unit
AOI	aircraft operating instructions
AOR	oiler replenishment
AOR	area of responsibility
APOJI	Automated Processing of Jezebel Information
ASE	aircraft survivability equipment
ASE	Automatic Stability Equipment
ASP	Augmented Surface Picture
AsuW, ASUW	antisurface warfare
ASW	antisubmarine warfare
ASWC	Antisubmarine Warfare Commander
B Comd	base commander
BAMEO	base aircraft maintenance engineering officer
BG	battle group
BMTF	Base Maintenance Test Flight
CABR	Canadian Airborne Regiment
CADO	Chief of Air Doctrine and Operations
CANCOMFLEET	Canadian Fleet Commander
CANFORCEHED	Canadian Forces Headquarters
CANTASS	Canadian Towed Array Sonar System
CAS	Chief of the Air Staff
CCoS	Chairman, Chiefs of Staff
CDC	Computing Devices Canada
CDR	critical design review
CDS	Chief of the Defence Staff
CF	Canadian Forces
CFAV	Canadian Forces Auxiliary Vessel
CFB	Canadian Forces base
CFDS	*Canada First* Defence Strategy
CFTO	Canadian Forces Technical Order
CMDO	Chief of Maritime Doctrine and Operations
CNIB	*Canadian Naval Intelligence Bulletin*
CNS	Chief of Naval Staff
CO	commanding officer

COE	centre of excellence
Comd	commander
COMM	communications
CONOPS	concept of operations
COS	chief of staff
COS AIR	Chief of Staff, Air
COS OPS	Chief of Staff for Operations
CoSC	Chiefs of Staff Committee
CPF	Canadian patrol frigate
CRAD	Chief of Research and Development
CSAR	combat search and rescue
CSC	Chiefs of Staff Committee
CSR	Committee of Staff Representatives
CSU	Clearance for Service Use
CTF	commander task force
CTG	commander task group
D/MND	Deputy Minister of National Defence
DAR	Directorate of Air Requirements
DC	direct current
DCOMD	deputy commander
DCOS READ	Deputy Chief of Staff Readiness
DDE	destroyer escort
DDH	destroyer helicopter carrying
DDL	destroyer deck landing
DEVAL	demonstration and evaluation
DFS	Director Flight Safety
DGAEM	Director General Aerospace Engineering and Maintenance
DGMEM	Director General Maritime Engineering and Maintenance
DGMS	Director General Maritime Systems
DHH	Directorate of History and Heritage
DICASS	directional command activated sonobuoy
DIFAR	direction frequency analysis and recording
DLIR	depot-level inspection and repair
DMA	Directorate of Maritime Aviation
DMA	Director Maritime Air
DMA	Directorate Maritime Air Requirements
DMAEM	Director of Maritime Aircraft Engineering and Maintenance
DMCS	Director Maritime Combat Systems
DMEM	Directorate Maritime Engineering and Maintenance
DMFD	Directorate of Maritime Force Development
DNAR	Director of Naval Aircraft Requirements
DND	Department of National Defence
DNR	Directorate Naval Requirements
DREA	Defence Research Establishment Atlantic
DTG	date-time group
DUSW	Director of Under Sea Warfare
EBS	emergency breathing system
EMC	electromagnetic compatibility
EMI	electromagnetic interference
FARE	forward area refuelling equipment
FCA	functional configuration audit
FDVA	flight deck vertical acceleration
FE	force employment
FG	force generation

FLIR	forward looking infra-red
FRP	force reduction programme
ft	feet
GDC	General Dynamics Canada
GHARS	Gyro Heading and Reference System
GPS	global positioning system
HDS	helicopter delivery service
HEELS	helicopter emergency egress lighting system
HELAIRDET	helicopter air detachment
HELTAS	Helicopter Towed Array Support
HF	high frequency
HHQ	high headquarters
HHRSD	Helicopter Hauldown and Rapid Securing Device
HIFR	helicopter in-flight refuellling
HMCS	Her Majesty's Canadian Ship
HMS	His Majesty's Ship
HOTEF	Helicopter Operational Test and Evaluation Flight
HOTEF	Helicopter Operational Test and Evaluation Facility
hp	horsepower
HQ	Headquarters
HRS	humanitarian relief sector
hrs	hours
HS	helicopter squadron
HS 50	Helicopter Anti-Submarine Squadron 50
HT	helicopter training
HU	helicopter utility
Hz	hertz
IBIS	In-Flight Blade Integrity System
ICT	Installation Control Team
IFC	instrument flight conditions
IMC	instrument meteorological conditions
IPVMS	instrument panel video monitoring system
IR	infrared
ISR	intelligence, surveillance and reconnaissance
kg	kilogram
km	kilometre
km/h	kilometres per hour
kt	knot
kW	kilowatt
LAC	Library and Archives Canada
lb	pounds
LCol	lieutenant-colonel
LLOW	low level over water
LMG	light machine gun
LSO	landing safety officer
LWR	laser warning receiver
m	metre
M&G	Maclean and Gibson
M&S	modelling and simulation
MAD	magnetic anomaly detector
MAD	mutual assured destruction
MAG	Maritime Air Group

MAGHQ	Maritime Air Group Headquarters
MARCOM	Maritime Command
MARLANTHQ	Maritime Forces Atlantic Headquarters
MARPACHQ	Maritime Forces Pacific Headquarters
MAWS	Missile Approach Warning System
MCT	mobile command team
METS™	Modular Egress Training Simulator
MH	maritime helicopter
MHC	maritime helicopter captain
MHz	megahertz
min	minute
MK	Mark
MND	Minister of National Defence
mph	miles per hour
MRP	mobile repair party
NATO	North Atlantic Treaty Organization
NB	Naval Board
NBP	naval boarding party
NDHQ	National Defence Headquarters
NM	nautical mile
NOF	Note on File
NPCC	Naval Policy Co-ordinating Committee
NS	Naval Staff
NSA	new shipborne aircraft
NSC	Naval Staff Committee
NVG	night vision goggle
OIC	officer in charge
Op	operation
OTU	operational training unit
PCA	physical configuration audit
PDR	preliminary design review
PM	prime minister
POM	performance of maintenance
RAF	Royal Air Force
RAST	Recovery Assist, Secure and Traverse
RCAF	Royal Canadian Air Force
RCD	Royal Canadian Dragoons
RCN	Royal Canadian Navy
RCS	radar cross-section
RG	record group
RHIB	rigid-hull inflatable boat
RN	Royal Navy
RRPM	rotor revolution per minute
RSD	Rapid Securing Device
RUET	rotary-wing underwater egress training
RWR	radar warning receiver
SAR	search and rescue
SCTF	Standing Contingency Task Force
shp	shaft horsepower
SITREP	situation report
SKR	Sea King Replacement
SME	subject matter expert

SOP	standard operating procedures
SOSUS	Sound Surveillance System
SOW	statement of work
SS	Steam Ship
SSL	Survival Systems Limited
SSN	nuclear submarine
SSO	senior staff officer
TACCO	tactical control officer
TB	Treasury Board
TBD	to be determined
TMA	target motion analysis
TRUMP	Tribunal Class Update and Modernization Project
TS	Technical Staff
UACL	United Aircraft of Canada Limited
UHF	ultra-high frequency
UK	United Kingdom
UN	United Nations
UNSC	United Nations Security Council
US	United States
USAAC	United States Army Air Force
USCG	United States Marine Corps
USN	United States Navy
USS	United States Ship
USSR	Union of Soviet Socialist Republics
VCNS	Vice Chief of Naval Staff
VCoSC	Vice Chiefs of Staff Committee
VHF	very high frequency
VMC	visual meteorological conditions
VNE	velocity not to exceed
VX 10	Experimental Squadron 10
W Comd	wing commander
WD	War Diary
WSM	weapon system manager
WWII	Second World War
YFR	yearly flying rate