



# The CH-148 Cyclone Heads Out To Sea

*The History of the Canadian Maritime Helicopter Project*  
By Kenneth I. Swartz

It was a turbulent 11-year journey from contract signing to first delivery, but the Sikorsky CH-148 Cyclone maritime helicopter finally entered Royal Canadian Air Force (RCAF) service in June 2015.

The new fly-by-wire Cyclone is derived from Sikorsky's commercial S-92, but is a major technological advancement as Canada's first true intelligence, surveillance and reconnaissance (ISR) helicopter. The CH-148 is equipped with a fully-integrated mission system, 21st-century sensors and a multi-mission cabin that will provide a quantum leap in capability when deployed on warships of the Royal Canadian Navy (RCN) or flying other missions.

## The Sea King Successor

Sixty years ago, Canada made the bold decision to operate large day/night all-weather anti-submarine warfare (ASW) helicopters from the decks of small destroyers to counter a growing Soviet submarine threat beneath the North Atlantic.

Skeptics said they couldn't operate a large Sikorsky Sea King-sized helicopter from the heaving deck of a destroyer in the stormy ocean, but the RCN persevered and perfected a helicopter "haul down" system that made small

*The first CH-148 Cyclone helicopter fully manned by Royal Canadian Air Force personnel successfully landed on a Canadian warship at sea on Jan. 27, 2016. (DND photo)*

deck landings and handling a routine operation, even in very rough seas.

The CH-124 Sea King has served Canada with distinction since 1963, but attempts to renew the country's maritime helicopter fleet have faced many political and procurement setbacks.

Then on Nov. 20, 2004, Canada placed a C\$5B (\$3.9B) order with Sikorsky for 28 CH-148 Cyclones to introduce one of the world's most advanced multi-role maritime helicopters to replace the 50-year-old Sea Kings.

The Cyclone program got off to a promising start, but suffered a series of well-publicized delays "which seems to be the norm for most sophisticated maritime helicopter programs, as well as many of Canada's recent large military procurement initiatives," said Canadian defense analyst Martin Shadwick with York University in Toronto.

"Canada has over 50 years of maritime helicopter experience operating the CH-124 Sea King helicopter platform, and now is on the cusp of deploying a new weapon system built to its specific requirements and performance parameters," explained William Falk, Sikorsky Program Director, Canadian Maritime Helicopter Program.

"The Capability Release 1.1 CH-148 Cyclone helicopter is a formidable maritime platform with the capability to perform anti-submarine warfare, anti-surface warfare, utility transport and search and rescue missions with the added benefits of additional speed, cabin space, range and endurance over the CH-124 Sea King; in its final configuration, the Cyclone will bring modern anti-submarine and anti-surface warfare capabilities to a level that can only be defined as world class."

Eight CH-148 Cyclones are now in service at 12 Wing Shearwater, Nova Scotia, and the entire fleet of 28 Cyclones is scheduled to be fully operational by 2021 following a series of block upgrades.

## Canadian Naval Aviation

Canadian naval aviators served with distinction in the First and Second World Wars, but it wasn't until 1946 that the Royal Canadian Navy (RCN) formed its own aviation arm at Shearwater, near Halifax to equip Canada's first postwar aircraft carrier.

The RCN acquired three Bell HTL (47D) helicopters in 1951, three Sikorsky HO4S-2s (S-55) in 1952, and three



The Royal Canadian Navy ordered the Sea King in the 1960s under the bold premise that it could operate the large helicopters from the decks of small destroyers. Today, the aircraft conducts frequent surface patrol missions. (Canadian Forces Combat Camera photo, January 2016)



The Helicopter Hauldown Rapid Securing Device (HHRSD) uses a "beartrap" (under the fuselage) to winch in the aircraft and grab the main probe; the tail probe guides the aircraft along the track. (Dept. of National Defence photo, September 2012)

Piasecki HUP-3s in 1954 for training, icebreaker and SAR duties. Then it acquired 10 Sikorsky HO4S-3 anti-submarine warfare (ASW) helicopters with dipping sonars to equip Helicopter Strike (HS) 50 Squadron, which first embarked aboard the aircraft carrier *Her Majesty's Canadian Ship (HMCS) Magnificent* in July 1955.

Almost from the beginning, the Canadian Naval Warfare Study Group had the revolutionary idea of deploying larger ASW helicopters with their own sonar and weapons onboard new *St.*

*Laurent*-class destroyers to extend the range of the ship's anti-submarine sensors and provide an independent search and attack capability.

RCN helicopters were already flying from the icebreaker *HMCS Labrador* in the Arctic, but could a larger ASW helicopter safely operate from the heaving deck of a 2,500-ton destroyer in the stormy and rough North Atlantic?

The RCN was entering uncharted waters, so sea trials were conducted with a RCN HO4S-3 onboard the *HMCS Buckingham* fitted with a temporary helideck in 1956, and a heavier RCAF Sikorsky H-34 (S-58) on the *HMCS Ottawa* in 1957.

The trials confirmed that a large helicopter could operate from a destroyer in rough seas, but the helicopter needed to be a robust design, the warship needed an enclosed maintenance hangar, and a system had to be developed to safely guide a hovering helicopter to the deck and

rapidly secure it to a rolling and pitching deck.

RCN committed to modifying seven *St. Laurent*-class and the last two *Annapolis*-class destroyers for helicopter operations before it selected a new turbine-powered day/night all-weather ASW helicopter.

The single-engine Kaman HU2K Seasprite was initially favoured by the RCN, but United Aircraft of Canada (Pratt & Whitney Canada) won the helicopter contract with a bid that included

Canadian assembly of the Sikorsky CHSS-2 at its plant in Longueuil, Québec. The RCN took delivery of 41 CHSS-2s between 1962 and 1969, 37 of which were assembled in Canada. The Sea Kings equipped the aircraft carrier *HMCS Bonaventure* and the new helicopter/destroyer fleet, and featured Canadian-made mission systems, strengthened landing gear and an automatic tail pylon folding system.

## "Beartrap" Haul Down System

Considered Canada's greatest gift to naval aviation, Canadian-designed and built helicopter haul-down, securing and traversing systems are now widely used by navies around the world. The Canadian "Beartrap" system — the Helicopter Hauldown Rapid Securing Device (HHRSD) — was first developed between 1962 and 1965 by the RCN's No. 10 Experimental Squadron (VX-10) in collaboration with Fairey Aviation of Canada, Sikorsky, P&WC and Dowty of Canada.

The system entered RCN service in April 1967 and was cleared for day and night operations to 30 degrees of roll and nine degrees of pitch up to Sea State 6 — a wave height of 13 to 20 ft (4 to 6 m).

The haul-down system uses a winch cable to reel in the hovering helicopter, much like a fisherman reeling in a trout. Landings are made during a lull in the ship's motion; the two steel jaws with spring-loaded teeth of the "beartrap" snap around a probe extending to the underside of the helicopter to firmly secure the aircraft to the ship's deck.

The helicopter-destroyer marriage added a long-range "hunter-killer" capability to the Navy's destroyer fleet that proved more cost effective than an aircraft carrier, and ultimately facilitated the *HMCS Bonaventure's* retirement in 1970.

## Canadian Armed Forces CH-124

The CHSS-2 was re-designated the CH-124 in 1968 following unification of the Canadian Armed Forces and became the CH-124A in the 1970s when the Sea King Improvement Program (SKIP) added a Litton APS-503 surveillance radar, modern avionics and sonobuoy chutes.





The Royal Canadian Air Force bought 15 CH-149 Cormorant helicopters — four seen here at Sydney Airport, Nova Scotia — for search and rescue missions. (Canadian Forces photo, March 2009)



The first prototype CH-148 demonstrated the automatic main rotor and tail folding capabilities. The folding composite tail pylons are built by Kaman's PlasticFab. (Sikorsky photo, December 2009)

Between 1963 and 1974, Sea Kings flew with HS 50 until it was split into HS 423 and HS 443. These squadrons, along with 406 Maritime Operational Training Squadron, were all based at Shearwater until HS 443 Squadron moved to Patricia Bay (Victoria International Airport), British Columbia, in July 1989 to support Canadian warships based on the west coast.

Until the end of the Cold War, the Sea King was primarily used to extend the anti-submarine capabilities of the destroyers and frigates on which it was embarked. Then, during the first Gulf War in 1990-91, six Sea Kings were rapidly modified with night vision and defensive systems to undertake surface surveillance missions on a lengthy helicopter air detachment (HELAIRDET) deployment with Canada's Naval Task Group in the Persian Gulf.

In 1995, HS 423 and HS 443 were re-designated Maritime Helicopter (MH) squadrons to more accurately reflect their expanding maritime surveillance and interdiction roles. The Sea King has now played a leading role in many of Canada's international peacekeeping and peace-making operations during the past quarter century.

## Replacing the Sea King

"Replacing the Sea King has been the subject of three program offices and two procurement programs," explained defense analyst Martin Shadwick. "The replacement program has always been very political and has run an obscene amount of time and absolutely everything possible has gone wrong."

The Sea King Replacement project of mid-1970s was followed by the

New Shipborne Aircraft (NSA) in the mid-1980s and then by the Maritime Helicopter Project (MHP) in the early 2000s.

In 1992, the Conservative government of Prime Minister Brian Mulroney signed a contract worth C\$5.8B (\$4.9B USD) to buy 50 EH101 helicopters from the Anglo-Italian consortium EH Industries Ltd, comprising 35 CH-148 Petrels for naval use and 15 CH-149 Chimos for search and rescue, with all the aircraft to be assembled at the Bell Helicopter Textron Canada plant in Mirabel, Québec.

A year later, Conservative Party Prime Minister Kim Campbell cut the naval CH-148 order from 35 to 28 units to save more than C\$1B on the eve of a national election.

"The Conservative government didn't do a very good job of explaining the continued relevance of maritime helicopters after the Cold War had ended," observes Shadwick. "This allowed Liberal party leader Jean Chrétien to gain a lot of political capital by claiming that Canada no longer required an expensive 'Cadillac' naval helicopter when a cheaper 'Chevrolet' helicopter would do."

The Liberals won the 1993 election and Prime Minister Chrétien immediately cancelled the EH101 order, but Canada ultimately paid C\$500M in cancellation fees.

"The irony is that in 1998 Canada ordered 15 search and rescue CH-149 Cormorants [a version of the EH101] for C\$790 million to replace its Boeing CH-113 Labradors, but politically the Chrétien government couldn't re-order the maritime version of the EH101 as well," said Shadwick. (Thirteen years

later, in 2011, Canada spent C\$164M to buy nine grounded AgustaWestland VH-71 Kestrels from the cancelled VXX US Presidential Helicopter program for spare parts and potential conversion to new CH-149 Cormorants).

The Sea King replacement was stalled for 10 years until Prime Minister Paul Martin replaced Chrétien in December 2003 and immediately issued a tender for a new maritime helicopter.

## Maritime Helicopter Project

In July 2004, Canada announced it had selected the Sikorsky CH-148 Cyclone over the (now) AgustaWestland AW101 and NH Industries MH90 (offered by Lockheed Martin Canada) to meet the Maritime Helicopter Project (MHP) requirement.

The Cyclone would become the third Sikorsky maritime helicopter to serve the Canadian navy in 50 years.

Compared to the Sea King, the CH-148 Cyclone offered a 10% increase in speed, a 36% increase in useable cabin space and a 40% increase in endurance at its maximum take-off weight (MTOW) of 29,300 lb (13.3 t), which is 2,800 lb (1.3 t) more than the civil S-92A.

"Sikorsky met all stated requirements of the military and at the lower cost," said Canadian Defense Minister Bill Graham at the time of contract award.

Two contracts were signed in November 2004 with prime contractor Sikorsky International Operations Inc. worth a total of C\$5B (\$3.9B USD). The first contract for C\$1.8B (\$1.4B USD) covered the acquisition of 28 CH-148 Cyclones and helicopter-related

modifications to 12 *Halifax*-class frigates. The second contract for C\$3.2B (\$2.5B USD) was for a 20-year in-service support (ISS) contract and included the construction of a Maritime Helicopter Training Centre with a full training suite of flight, mission and maintenance simulators at 12 Wing Shearwater, Nova Scotia.

Sikorsky formed a CH-148 engineering and program management team in Stratford, Connecticut, and established major sub-contractor partnerships with General Dynamics Canada (GDC) in Ottawa, Ontario, to lead the CH-148 mission systems integration, and with L-3 Communications MAS (Military Aircraft Services) in Mirabel, Québec, to provide in-service support (ISS).

The Cyclone would be designed to meet the specific Canadian Forces maritime requirements, like operating in up to Sea State 6 conditions, and would be capable of conducting anti-submarine warfare (ASW), anti-surface warfare (ASuW), utility transport, search and rescue (SAR), and other maritime helicopter missions, as well as providing tactical transport for national and international security efforts. A unique feature of the maritime helicopter is the capability to rapidly configure to a 21-troop seat configuration.

The main airframe features included advanced fly-by-wire flight controls, a full glass cockpit, automatic main rotor and tail folding, shipboard haul-down system, and Rotor Ice Protection System



*In this photo of the first official training flight in Oct. 2013 at Shearwater, the square missile approach warning systems on either the nose are evident, with the round ESM sensors below them. The FLIR ball is just ahead of the nose gear, facing rearward for protection. The winch and sponson-mounted torpedo rack are also clearly visible. (DND photo)*

(RIPS), enabling safe flight into known icing conditions. For combat, the CH-148 could be equipped to carry two Mk. 46 homing torpedoes on BRU-14 folding weapons pylons and a door-arm mounted general-purpose machine gun.

The first Cyclone was scheduled to arrive no later than 48 months after the contract award — i.e. in November 2008 — with other aircraft following at monthly intervals, with government bonuses for early delivery and penalties for late delivery.

## Mission Systems & Sensors

General Dynamics Canada (GDC), now known as General Dynamics Mission Systems–Canada, was born as Computing Devices Canada in 1948. For the CH-148 program, GDC dedicated more than 400 employees — in Ottawa, Calgary, Shearwater and the Sikorsky plant in Florida — to select, purchase, integrate and install the mission systems.

The company's work scope included primary responsibility for the CH-148 integrated mission system (IMS) and Sonobuoy Acoustic Processing System (SAPS). The Cyclone and its crew are now able to undertake missions independent of the ship when airborne, utilizing a self-contained radar, dipping sonar and sonobuoys to detect, track and prosecute targets of interest.

At the core of GDC's contribution is the Mission Data Management System (MDMS), a highly capable central computer system that provides an integrated operator interface for the helicopter's sensor suite, reducing crew workload and providing enhanced mission capability. A major design objective for the CH-148 was to simplify data management by integrating as many elements as possible to provide enhanced tactical and situational awareness and address the size, weight and electric power challenges.



*From tip to tail, the most obvious underside features in this photo are the FLIR, OceanEye radar, sonobuoy chute, cargo hook, C-RAST probe, dipping sonar (off axis), antenna, rear ramp and tail fold. (Photo © Michael Durning, used with permission, March 2015)*





The fifth S-92A was modified as a prototype fly-by-wire S-92F, with first flight on Dec. 20, 2007. (Sikorsky photo)



The first CH-148 (No. 148801) made its initial flight on Nov. 15, 2008. The unpainted aircraft highlights the composite self-folding tail structure. (Sikorsky photo)

MDMS uses information-layering techniques to present a tactical picture on a single display, with data layers from individual acoustic, radar, electro-optical and self-defense sensors, and other inputs easily accessible than can be added or deleted on a map as an operator requires.

The MDMS has two workstations for the Tactical Coordinator (TACCO) and Sensor Operator (SENSO) in the Cyclone cabin with 20 inch (50.8 cm) displays and 12 inch (30.5 cm) panels to access powerful tools, such as graphical aids, digital maps, fuel planning and a terrain database. In the cockpit, pilots can view a GDC tactical display in the middle of the Rockwell Collins integrated cockpit.

The CH-148 is also designed to share

sensor data and intelligence with other aircraft and ships using the Tactical Common Data Link (TCDL). Each of the 12 *Halifax*-class frigates will also be upgraded with a new CH-148 mission planning workstation, where mission plans can be uploaded to a helicopter before a flight, and crews can download sensor, tactical, and Health and Usage Monitoring Systems (HUMS) data after a flight for analysis.

Building on lessons learned during five decades of “blue ocean” Sea King operations and other missions, the CH-148 — with its sensor fusion technology — is much better outfitted than the aircraft it will replace. For the ASW missions, the CH-148 is provisioned with an L-3 Oceans Group Helicopter

Long-Range Active Sonar (HELTRAS) DS-100 tethered sonar, whose low frequency design has demonstrated long-range detection and wide area search capabilities in both shallow and deep waters. Underwater target detection is further enhanced with GDC’s sonobuoy acoustic processing system, which allows up to 16 sonobuoys to be controlled and processed onboard the helicopter, which is a new ASW capability only briefly demonstrated onboard a handful of Sea Kings.

A belly-mounted Telephonics AN/APS-143 (V)3 OceanEye multimode radar provides long-range 360° surface detection coverage and Inverse Synthetic Aperture Radar (ISAR) imaging to allow classification of radar contacts. The system also provides overland Synthetic Aperture Radar (SAR) imaging/mapping, weather avoidance and Search and Rescue Transponder (SART) beacon modes.

Other CH-148 sensors include a FLIR Systems Star SAFIRE III electro-optical/infrared sensor on the nose, a Spectrolab Nightsun searchlight on the left side, and an AN/ALQ-210 Electronic Surveillance Measures (ESM)/Radar Warning Receiver (RWR) that allows the CH-148 to passively develop a consolidated maritime picture of the radio frequency emitters in the operating area. Self-defense systems include missile approach and laser warning, along with infrared jamming, and chaff and flare countermeasures.

## Fly-By-Wire

Sikorsky’s original prototype S-92, which made its first flight in December 1998, achieved FAA certification in 2002 and first delivery to launch customer PHI, Inc. in September 2004.

The military H-92 Superhawk was unveiled at the 2003 Paris Air Show. Sikorsky soon proposed it for the US Navy’s original VXX Presidential Helicopter Replacement Program (for which the VH-92 was eventually selected in 2014) and the US Air Force’s original Combat Search and Rescue Replacement Vehicle (CSAR-X) competition (with the HH-60W selected in 2014).

Meanwhile, the fifth S-92A (N592SA) was modified as a prototype fly-by-wire (FBW) S-92F, with ground testing

beginning in July 2007, followed by first flight on Dec. 20, 2007, at Sikorsky's Development Flight Center in West Palm Beach, Florida. The S-92F would be the basis for the new CH-148 Cyclone to be powered by marinized General Electric CT7-8A engines (and all of the CH-148s were registered with the US FAA as "S-92F" model helicopters).

Sikorsky developed the FBW flight control system in association with BAE Systems and worked with the National Research Council of Canada Institute for Aerospace Research (NRC Aerospace) in Ottawa to develop FBW control laws utilizing the NRC's FBW Bell 412 in-flight simulator.

The FBW system consisted of a flight control computer, two pilot control sticks, and sensors for processing pitch, roll and yaw data. Eliminating the traditional mechanical linkage saved more than 200 lb (91 kg) in weight, reduced maintenance costs, added capability and improved performance and mission effectiveness by reducing pilot workload. The FBW system also provided trim control, stability augmentation, automatic flight control modes and flight director functions.

## Contract Revisions

In January 2008, Sikorsky advised the Canadian government that it would not meet the original November 2008 deadline for first delivery under the fixed-price contract. By December 2008, Canada worked towards resolution with Sikorsky, amending the contract and added C\$117M (\$94M USD) — C\$77M (\$62M USD) to the helicopter purchase and C\$40M (\$32M USD) for the 20-year

in-service support contract. The new contract included a tiered schedule with delivery of interim helicopters in November 2010 and delivery of fully compliant helicopters beginning in June 2012.

The additional funding was targeted at performance "upgrades," including the replacement of the GE CT7-8A1 with a more powerful GE CT7-8A7 turboshaft (certified in May 2012).

## First CH-148 Flight

The first CH-148 (No. 148801) made its initial flight on Nov. 15, 2008 — less than a year after the first S-92F.

The CH-148 was assembled using major components produced by Sikorsky S-92's international supply chain (Mitsubishi, Gamesa, Embraer, AIDC and Jingdezhen Helicopter Group/CATIC) with Kaman's Plastic Fabricating Company (PlasticFab) in Wichita contracted to produce 28 fully-assembled folding composite tail rotor pylons. The baseline CH-148 airframes were assembled at Sikorsky's Coatesville, Pennsylvania, plant, but all assembly and flight operations was been concentrated at Sikorsky's Development Flight Center in West Palm Beach.

The first CH-148 outfitted with an Integrated Mission System (IMS) hardware flew in West Palm Beach in August 2009, but development of fully compliant mission system software became a longer challenge.

The prototype CH-148 arrived at Canadian Forces Base Shearwater in February 2010 for the first round of Ship Helicopter Operating Limitations (SHOL) trials aboard *HMCS Montreal*, a *Halifax-*

class frigate focusing on the three mission phases — helicopter storage, deck operations and flight operations.

A second round of CH-148 SHOL trials took place on the *HMCS Montreal* during 42 days at sea in January-February 2011 that demonstrated launch and recovery — using the Indal Technologies Canadian Recovery, Assist, Securing and Traversing (C-RAST) haul-down system — as well as vertical replenishment, helicopter in-flight refueling (HIFR), rescue hoist and deck handling under day, night and night vision goggle (NVG) flying conditions in very demanding Sea State conditions.

[The C-RAST design is similar to the "beartrap" system used for the *Sea King*, but the geometry had been modified to match the *Cyclone's* airframe and landing gear configurations — the *Sea King* has a tail wheel, the *Cyclone* a nose wheel — as well as the higher operating weights and deck loading. Sikorsky contracted with Indal Technologies (now a part of Curtiss-Wright Defense Solutions, see "Different Course, Same Direction," *Vertiflite*, March/April 2016) to supply 12 C-RAST systems, one each for the 12 *Halifax-class* frigates in service. The new system was designed at Indal's plant in Mississauga, Ontario, and operationally tested on a *Halifax-class* frigate before entering production.]

To support the training of the initial cadre of military personnel, Sikorsky stationed four company-owned Interim Maritime Helicopters (IMH) at 12 Wing Shearwater as ground-based training aids. The first interim *Cyclone* arrived on May 13, 2011, (MH806) and three more in the summer of 2012 (MH804, MH808 and MH807) with all the aircraft painted



A second round of Ship Helicopter Operating Limitations (SHOL) trials took place on the *HMCS Montreal* with the CH-148 prototype during 42 days at sea in January-February 2011. (Sikorsky photo, February 2011)



The first Sikorsky-owned Interim Maritime Helicopter (IMH) arrived at Shearwater in May 2011 to support training of Canadian Forces aircrew and technicians. For the first time, the *Cyclone* was in Canada with military markings. (Sikorsky photo)





*Helicopter Testing and Evaluation Facility pilots carry out pre-flight checks in a CH-148 Cyclone Flight Simulator at the Sikorsky Maritime Helicopter Training Centre at 12 Wing Shearwater, Nova Scotia on June 4, 2015. (DND photo)*

in the colors of the Royal Canadian Air Force, whose historic name was revived in 2011. The RCAF was also heavily engaged in developing new operational and training doctrine for the more versatile and capable maritime aircraft.

## Program Challenges

In October 2010, Canada's Office of the Auditor General released a report highly critical of the way the Canadian military and government employees managed the acquisition of the Sikorsky CH-148 Cyclone and Boeing CH-147F Chinook and their internal programs to control risk and cost. (The report notably did not examine the practice or performance of either company).

The report said the 2004 government procurement strategy was based on "lowest price" and the Department of National Defence (DND) presented both helicopters as "off the shelf" technologies with low risk, when in fact the CH-148 was actually a major development program with an initial budget of C\$612M (\$471M USD) for non-recurring engineering costs: "In our opinion, National Defence did not adequately assess the developmental nature of this aircraft, and the risks related to cost and the complexity of the required technical modifications were underestimated." The report also stated that "National Defence has been slow to assess the full life cycle costs, and some elements of these costs have still not been completely determined."

Following further program and delivery delays, Canadian Defence Minister Peter MacKay didn't pull punches in July 2012 when expressing his frustration with the 20-year fiasco to replace the aging and high-maintenance Sea King. "This is an example of how procurement can go badly wrong," said MacKay. "This is the worst procurement in the history of Canada, including the \$500-million cancellation costs that are attached to the Maritime helicopter program and then the costs of further maintenance to fly 50-year-old helicopters. They're going to go right out of aviation service and into the museum in Ottawa. And that's not a joke."

In the spring of 2013, the Canadian government engaged Hitachi Consulting to review and assess the viability of the CH-148 Program and its continuation. The Hitachi Report was critical of the government procurement process and that the government continued to treat the CH-148 like an off-the-shelf project instead of a full-scale development program. The report recommended a complete overhaul of the project management process and suggested the government let go of specifications that couldn't be met by any existing naval helicopter and trade these off against other cost, space and schedule improvements.

"The program itself is among the most sophisticated ever conducted by Sikorsky, and it continues to move

forward," said Sikorsky in a statement in 2013, but the fixed-price helicopter program was proving very costly to Sikorsky and its (then) parent, United Technologies Corporation.

In August 2013, Preliminary Cyclone Training commenced for a small number of pilots and ground crew, with training flights finally commencing on Oct. 11, 2013, at 12 Wing Shearwater. The Sikorsky-owned Cyclones were flown by a split cockpit of Sikorsky and RCAF pilots.

By late 2013, Sikorsky had four interim CH-148s in Canada, six stored in a UTC hangar at Plattsburgh Airport, New York, and all 28 Cyclones "in the build cycle."

## Contract Amended

After publically considering canceling the Cyclone and buying another helicopter in late 2013, the Canadian government adopted the consultant's recommendations to get the CH-148 program back on a workable schedule and provide Sikorsky and its subcontractors with the funding required to complete development work and deliver a world-leading maritime helicopter.

On June 18, 2014, Sikorsky and DND signed amendments to the CH-148 contracts, bringing them to a total of C\$7.6B — C\$1.9B for the CH-148s and C\$5.7B for the amended in-service support contract that was extended for an additional 10 years until 2038.

The amended contract finalized the scope of the aircraft, introduced a new governance model (with integrated teams from DND and Sikorsky) and established a phased approach for the delivery of interim Block 1 helicopters starting in June 2015, delivery of Block 2 aircraft starting in June 2018, and the fielding of a fully capable fleet of 28 aircraft by 2021.

## Entry into RCAF Service

On June 19, 2015, Canada officially accepted six Block 1 CH-148 Cyclones at 12 Wing Shearwater. Then, on June 22, five aircrew of the Helicopter Operational Test and Evaluation Facility (HOTEF) at Shearwater made history when they flew a CH-148 (148820) for the first time as an asset of the RCAF.

Prior to this date, all Canadian

Cyclone flights had been made by split Sikorsky and RCAF crews, with the Canadian flying expertise drawn from the Aerospace Engineering Test Establishment (AETE) at 4 Wing Cold Lake, Alberta, or HOTEF.

During the course of the Cyclone flight test program, high altitude testing was also performed at Montrose, Colorado; cold weather and icing testing was performed in Duluth, Minnesota; climactic testing was carried out at the facilities situated at Eglin Air Force Base in Florida; self-defense, RWR/ESM and torpedo release testing was performed at the Naval Air Station Patuxent River, Maryland; and sonar testing at the Atlantic Undersea Test and Evaluation Center (AUTEC) range in the Bahamas.

All sea trials have taken place from Halifax, with the Cyclone going to sea for the first time in RCAF service in February 2016 on the back of *HMCS Halifax*, one of the RCN's recently modernized frigates, for further operational testing and evaluation.

As of March 2016, all 28 Cyclones have been assembled at the West Palm Beach plant and all but two aircraft have flown.

## Block Upgrade Program

After many years of Canada insisting that Sikorsky deliver a "fully capable" helicopter, both parties agreed to a phased delivery approach for the CH-148 Cyclone that includes two major Blocks with minor updates within each Block.

Block 1 contains three capability release phases — Block 1, Capability Release 1.1 and Capability Release 1.2. Each capability release delivers more operational capability related to shipboard operations, survivability, mission systems functionality and dynamic component life.

Six Block 1 aircraft were delivered in



*The General Dynamics Canada integrated mission system is part of the mission simulator at the Maritime Helicopter Training Centre at 12 Wing Shearwater. (Sikorsky photo, 2011)*

June 2015 and two Capability Release 1.1 aircraft were delivered by December 2015. The Capability Release 1.1 aircraft have a fully functioning mission suite and will achieve initial operational capability in April 2018, performing ASW/ASuW missions while operating from the RCN's *Halifax*-class ships. The Capability Release 1.2 will introduce dynamic component upgrades, primarily to the blades and swashplate, to meet the component life specified in the contract.

The Block 2 aircraft will be delivered with airframe and mission system enhancements that will allow their use in a wider range of environmental conditions and threat conditions. Delivery of the first six Block 2 aircraft will be completed by June 2018 and the remaining deliveries and aircraft upgrades by December 2021 to provide a fully compliant aircraft.

At each stage in the upgrade program, each aircraft variant will require a period of training and operational testing and evaluation.

The 20 CH-148s still in the US are in various stages of refit/upgrade to support delivery in final configuration, with two currently assigned to support Block 2 flight test activities in West Palm Beach.

The Sikorsky Support Services facility at Troy Municipal Airport in Alabama is performing CH-148 airframe modifications to extend the airframe useful life as part of the Block 2 upgrade. The structural modifications will provide the fatigue life required to endure the high loads during repeated deck landings on Canadian warships in high sea state conditions.

Several weight reduction initiatives have also been identified as part of the Block 2 upgrade to ensure the final configuration aircraft meet full mission performance requirements.

The final Capability Release 2.1 upgrade kits will be delivered between January 2020 and December 2021 and be installed by the RCAF in Canada.

The eight Cyclones now in service with the RCAF will all eventually return to Sikorsky in Troy to be converted into Block 2 aircraft.

Of the 28 Cyclones, nine aircraft will be positioned on the west coast at 443 Marine Helicopter Squadron at Patricia Bay, with the remaining 19 aircraft located at 12 Wing Shearwater.

The Sea King Enhancement Project (SKEP) originally approved in June 2013 to provide a transition vehicle to the CH-148 has been scaled back to a single flight test prototype for training, testing and evaluating crews. The retirement of



*Members of 12 Wing Shearwater at the official acceptance ceremony for the first six Cyclones on June 19, 2015. (DND photo)*



the legendary Sea King has now begun, with the first four removed from flying status during the winter of 2015-2016.

## Naval Fleet

The delivery of Block 2 helicopters will coincide with the completion of the lengthy *Halifax*-class Modernization (HCM) / Frigate Equipment Life Extension (FELEX) in 2018 and allow Canada to deploy worldwide ultramodern warships and maritime helicopters together.

When the Cyclone was first ordered in 2004, the Canadian Navy had a shipborne helicopter capacity for 26 helicopters (including ships in dry dock), but this dropped to 14 helicopters (12 *Halifax*-class frigates and one *Tribal*-class destroyer with a double hangar) by 2016, resulting in an abundance of maritime helicopters for a diminished naval fleet.

In the next decade, the RCN plans to introduce three new Joint Support Ships (with two organic CH-148 each) and six new Arctic/Offshore Patrol Ships (with helidecks, but no C-RAST or hangar), and start acquiring up to 15 new Canadian Surface Combatant (with one organic CH-148 each) to replace the *Iroquois*-class and *Halifax*-class warships.

## In-Service Support

Canada typically flies its military aircraft hard and retains them for a very long time. This operational reality has shaped Canada's approach to in-service support programs, which have increasingly transferred more risk to the aerospace industry with the goal of achieving high operational readiness, and long-term cost and logistical benefits.

L-3 MAS, based at Mirabel, Québec, has lead responsibility for the Cyclone's in-service support, which includes in-service support engineering activities, spares management, and associated supply chains, as well as the provision of a training facility and training for the RCAF aircrew and maintenance personnel.

The company traces its roots to Bombardier Canadair, which won a contract in 1986 to provide engineering, upgrade and maintenance support for the RCAF's fleet of CF-18 Hornet fighter jets; the unit was acquired by L-3 Communications in 2003.



After more than a decade of development, the CH-148 Cyclone — one of the most sophisticated and capable maritime weapon systems ever built — is now operational with the Canadian Armed Forces. (DND photo, March 2016)

In 2005, L-3 MAS broke ground on the construction of the C\$45M (\$35M USD) Maritime Helicopter Training Centre at 12 Wing Shearwater that now houses the flight, mission and maintenance simulators, and serves as the home for 406 Maritime Operational Training Squadron.

The Cyclone training suite includes: two operational mission simulators, each integrating a Full Flight Simulator (FFS) made by Rockwell Collins and a mission simulator built by GDC (a fuselage and complete replica of the on-board mission environment); six mission procedures trainers built by GDC; one aircraft maintenance trainer; and three engine change unit part task trainers built by Rockwell Collins.

Another support facility will be located in British Columbia to support the nine Cyclones to be assigned to MH 443 squadron based Patricia Bay.

## Conclusion

The CH-148 Cyclone aircraft is one of the most sophisticated and capable maritime weapon systems ever built. The combination of the fly-by-wire flight control system and the ability of the mission system to build the tactical map on board the aircraft will provide a high degree of sophistication and situational awareness.

It is a true multi-mission aircraft that is capable of being re-tasked in flight to perform almost every mission it is assigned from anti-submarine warfare, anti-surface warfare, utility transport, and search and rescue, to tactical troop transport.

The quest for a Sea King replacement has now stretched on for four decades, with the last 11 years focused on the CH-148. Finally, the Cyclone has reached Canadian waters and is on a path to successful operations for decades to come.

## Acknowledgements

The author was first exposed to the Sea King story while researching the book *Power: The Pratt & Whitney Canada Story* for Canav Books in 1987-1988.

In celebration of the 50th anniversary of the Sea King in 2013, Canadian naval aviation historians and museums published numerous articles, some of which were published by the Canadian Forces Aerospace Warfare Centre in *Canadian Aerospace Power Studies Volume 5: Wings for the Fleet: Fifty Years of the Canadian Sea King*, edited by W. A. March.

## Further Reading

*The Politics of Procurement: Military Acquisition in Canada and the Sea King Helicopter*, by Aaron Plamondon, UBC Press, 2009.

*Uncharted Waters: The Development of the Helicopter Carrying Destroyer in the Post-war Royal Canadian Navy, 1943-1964*, by Michael Shawn Cafferky, Carleton University, 1996.

*"Certified Serviceable": Swordfish to Sea King; The Technical Story of Canadian Naval Aviation by Those Who Made it So*, Peter Charlton & Michael Jeffrey Whitby (Editors), CNATH Book Project, 1995.

