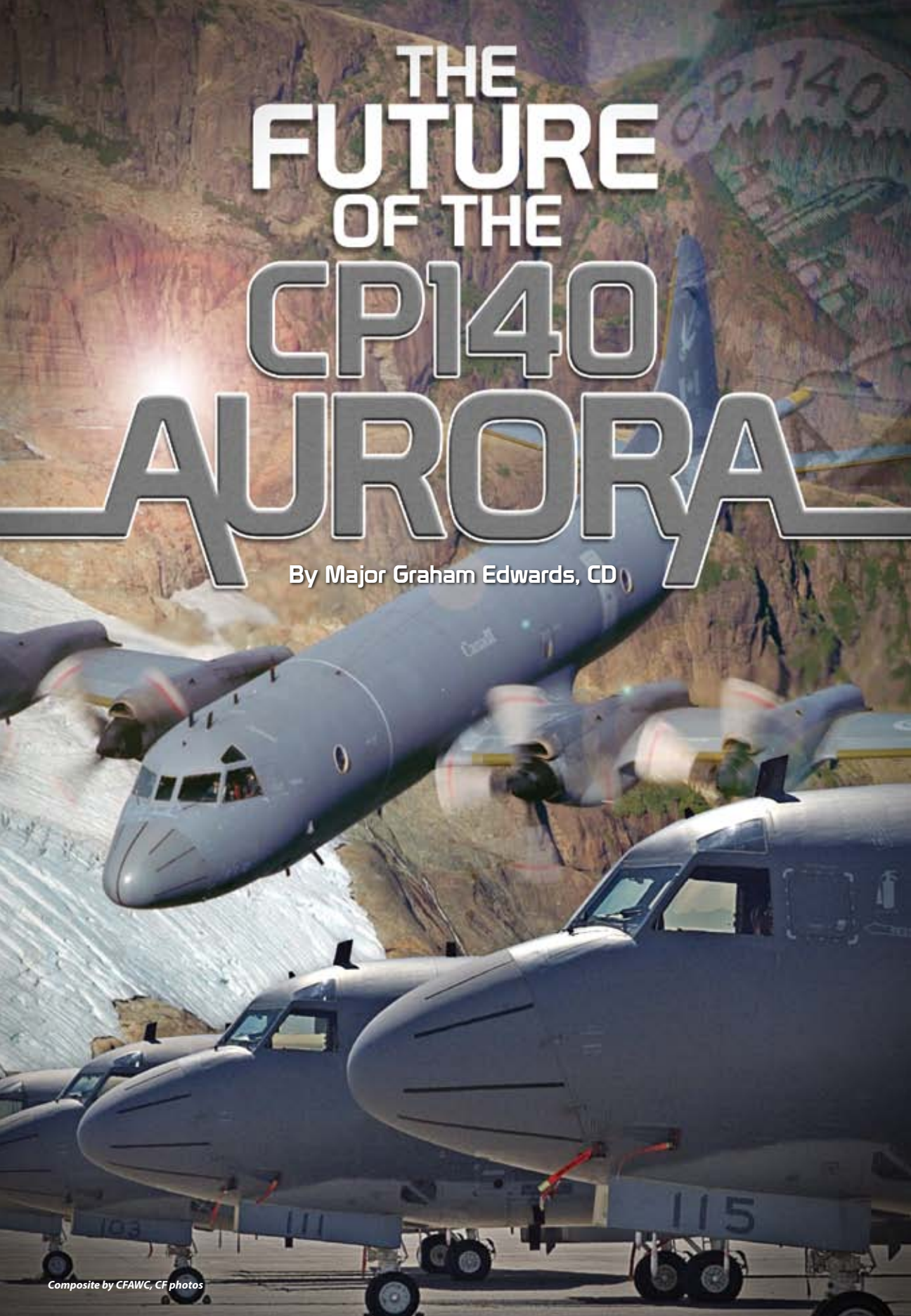
THE FUTURE OF THE CP140 AURORA

By Major Graham Edwards, CD



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When asked to write an article about the future of the CP140 Aurora, I was initially hesitant to accept. After all, I am a Staff Officer within the Chief of the Air Staff, and the influence I wield could potentially persuade political, industrial, and military leaders alike to invest in whatever resources I recommend... well, not quite. Unfortunately, I am not the Alan Greenspan of long-range patrol aircraft (LRPA), and believe me when I say that there is a well established (and quite lengthy) process through which the requirements and capabilities of the Canadian Forces (CF) are defined and acquired. As such, I figured my proverbial "six o'clock" was sufficiently covered, so I eagerly embraced the challenge of gazing into the long-range patrol crystal ball that every Staff Officer is issued upon their arrival to Ottawa, to reveal what the future has in store for the CP140 Aurora.

In an attempt to forecast the future of the CP140, I thought it prudent to review the origins of Canada's LRPA. In fact, as far back as 1939, the government at the time expressed concern over the protection of Canada's vast territories and maritime approaches. In response, the Department of National Defence (DND) established the home war establishment (HWE) to build the Air Force, much like the Canada First Defence Strategy (CFDS) is aimed at rejuvenating the Canadian Forces of today. As anticipated, the Second World War (WWII) ensued, and Canada's investment in the HWE paid off, ensuring that a viable anti-submarine warfare (ASW) and anti-surface warfare (ASUW) capability was delivered for both Canada and its Allies. Post-war cutbacks saw a lull in LRP activity, but with the advent of the cold war, Canada found itself back in the game of coastal and Arctic patrol. The arrival of the CP140 Aurora (a variant of the United States Navy P-3 Orion) in 1980 was a momentous occasion that placed Canada at the forefront of LRP capability amongst its Allies. However, years of military cutbacks and lack of funding for the Aurora's mid-life upgrade resulted in a serious deterioration in Canada's LRP capability. In the 1990s, the Aurora Incremental Modernization Program (AIMP) was created to rectify the erosion of LRP capability, but enduring fiscal constraints required the $1.67 billion upgrade to be spread over several years, thus delaying its delivery. During the modernization process, the discovery of severe corrosion across all P-3 fleets led to the Aurora Service Life Extension Program (ASLEP). Escalating costs associated with AIMP and ASLEP resulted in their temporary suspension and an initial review of Aurora replacement options.

In 2008, the CFDS was issued with very clear direction on the future of the Aurora. The CFDS identified the requirement to replace the Aurora starting in 2020 with 10–12 patrol aircraft as a part of a new surveillance system of systems. However, the efforts to find a suitable replacement and to establish a surveillance system of systems by 2020 present their own challenges. The post-AIMP Aurora will be a world class command and control, intelligence, surveillance and reconnaissance (C2ISR) platform. As such, there are notable advantages to producing more than the current 10 platforms, and maintaining the option to extend the fleet beyond 2020. This option, if properly supported, has the potential to become a mitigation strategy for the development and delivery of both the Aurora replacement and the CF's system of systems as a whole.

CANADA'S LONG-RANGE PATROL – THE ORIGINS

The birth of Canada's LRP capability could probably be marked by the establishment of the Eastern and Western Air Commands of the Royal Canadian Air Force (RCAF) in 1938 in response to the growing tensions between the United States and Japan on the Pacific Coast, and to the impending threat of war in Europe on the Atlantic Coast. These two commands, combined under the HWE, were part of the DND's air defence plan to protect Canadian territories from airborne, surface, and subsurface attacks. The resources required for the HWE read like a Christmas list calling for a total of 49 squadrons, consisting of 380 Hurricane fighters, 244 Mosquito bombers, 144 Conso flying boats, 40 Vultee Vengeance light

bombers, and transport aircraft for a total cost of $151 million. "This also meant adding 989 officers and 11,347 airmen, for an additional cost of $216 million."[1] It was an impressive defence strategy, similar in grandeur to the current CFDS, and equally challenged by unforeseen changes to requirements, personnel issues, and insufficient industrial capacity both at home and abroad. As a result, during the first months of WWII, the Canadian squadrons that conducted the vital ASW and surface surveillance roles, lagged in capacity and capability behind their British and United States (US) counterparts. Ultimately, the 49 squadrons would be formed, but not in direct support of the HWE. Most squadrons operated overseas in operations in Britain, Northwest Europe, North Africa, and Southeast Asia. By 1942, Canada had six squadrons equipped with Bristol Beaufighters, Blenheim and Hudson light bombers, Vickers Wellingtons and Consolidated Catalina flying boats serving under the British Coastal Command in support of the ASW and ASUW missions. By 1943, the RCAF received 148 American built B-24 Liberators also known as Very Long Range (VLR) aircraft because of the 12- to 15-hour missions they would conduct. The extended range and persistence capability enabled Coastal Command patrols to cover the mid-Atlantic gap, where U-boats previously operated without risk of being attacked by Allied aircraft.[2]

Following the end of the war, the RCAF was reduced to five squadrons and about 12,000 personnel. Peacetime LRP activities consisted of aerial photography, mapping and surveying, search and rescue, and mercy missions. Unfortunately, this lull in activity did not last long, and by the end of 1948, the Soviet Union ensured peacetime activities were no longer a priority for the Air Force. Canadian built Lancaster Mk X aircraft were pulled out of storage, overhauled, and placed into service as maritime reconnaissance aircraft to search for Soviet submarines or as Arctic reconnaissance aircraft tasked to conduct ice reconnaissance (recce), assert Canadian sovereignty, or inspect and photograph Soviet vessels and other items of interest in areas in and adjacent to Canadian territory. Other unmodified Lancasters served as photo reconnaissance aircraft. By 1955, the RCAF grew to a strength of 54,000 personnel and 41 squadrons of which the LRP sqns were equipped with a combination of Lancasters, Lockheed Martin Neptunes, and Canadair Argus aircraft. By 1968, the Lancaster and Neptune aircraft were retired, leaving only 32 Argus aircraft as the mainstay of Canada's LRP.

In February 1959, the US Navy awarded Lockheed Martin a contract to develop a replacement for their aging P-2 Neptune, and in July 1962, the first P-3 Orion entered into service. Canada would follow suit but 20 years later. In 1971, DND determined that a fleet of 20–30 modern aircraft would be required to replace the 32 Argus aircraft. This number was later refined to 24 aircraft, but fiscal constraints and what appeared to be a unilateral decision made by the Trudeau government further reduced the number to 18 without any apparent change to its missions. In May 1980, Canada took delivery of the first of 18 CP140 Auroras, the Canadian variant of the P-3C aircraft. The upside to our tardy replacement was that the CF took advantage of the opportunity to incorporate the advanced 1970's mission system of the Lockheed S-3A Viking, thus giving the Aurora an unprecedented level of systems integration along with the range and endurance of a P-3 Orion. At the heart of this mission system was a general purpose digital computer (GPDC) that processed acoustic, electronic warfare support measures (ESM), radar, and forward looking infra-red (FLIR) sensor data for display to crew members via their own multi-purpose displays (MPDs). This new level of integration gave the crew the capability to process the same data from multiple stations simultaneously, to manage workload by assigning tasks for a given sensor from one station to another, and to integrate data from each sensor to detect, identify, classify, and track subsurface, surface, and airborne targets. The Aurora's ASW and ASUW capability was unprecedented for its time and easily met the intelligence, surveillance and reconnaissance (ISR) needs of Canada.

The downside of the situation was that with only 18 aircraft and high operational demands, the yearly flying rate (YFR) was nearly double that of similar P-3C aircraft flown by other nations.[3]

THE CP140 AURORA – ON STATION

Even to this day, the CP140 constitutes Canada's only airborne strategic surface (sea and land) surveillance capability and remains a crucial element of Canada's maritime combat team. It is the only CF aircraft capable of conducting ISR and sovereignty patrols at the furthest extent of Canada's maritime approaches and within the Arctic. However, without its mid-life upgrade in the 1990s, the capability of the CP140's 1970 technology started to erode. Other operators of the P-3Cs benefited from regular update packages from the U.S. Navy; however, the distinctive configuration of the CP140 was a unique problem the CF had to solve on its own.[4] Budget cuts and force reductions exacerbated by a change in government in 1993 resulted in the cancellation of over $15 billion worth of planned capital projects and operating budgets. Chopped was the mid-life upgrade of the CP140 Aurora and 40 per cent of its YFR, reducing 1998 rates from 19,200 to 11,500 hours. In response, the AIMP was implemented, along with initiatives to ensure the airframe's viability to 2015, including the participation in the U.S. Navy's Service Life Assessment Program that provided the CF the data to evaluate the feasibility of extending the life of the fleet beyond 2015. The result of the latter was the initialization of the ASLEP.

Starting in 1998, the AIMP was implemented to launch the Aurora into the 21st century, providing Canada a maritime, Arctic, and overland surveillance capability second to none. This enhanced sensor, communication, and mission system capability will ensure the CF can respond to the traditional maritime roles, as well as the expanded new ISR roles demanded of the modern day LRP aircraft. In order to make the $1.67 billion price tag more palatable, the program was divided into four distinct blocks consisting of 23 individual projects, as summarized in Table 1. Initially, all 18 Aurora aircraft were to be modernized with a completion date of 2010. However, Block IV would never be funded, and managing the servicing schedule while continuing to conduct ongoing operations would prove to be more challenging than expected. The result was further slippage in the completion date until the 2012 time frame. To make matters even worse, in 2000, a fleet-wide corrosion problem was discovered, compromising the structural integrity of the Aurora's wings and horizontal stabilizer. Analysis determined that without addressing these concerns or significantly reducing the yearly flying rates, the CP140 would reach its end of life by the 2012–2015 timeframe.

BLOCK	EQUIPMENT
Block I Legacy Systems	• **replace high frequency radio** • **replace cockpit voice recorder** • **replace flight data recorders** • **update sonobuoy receiver antennae components** • **new iridium satellite communications (satcom)**
Block IIA Navigation Systems	• **new embedded GPS inertial (EGI) and control display unit (CDU)** • **replace flight director (FDI) and horizontal situation indicator (HSI)** • **replace autopilot** • **new radar altimeter** • **new airborne collision avoidance system (ACAS)**
Block IIB Communication Systems	• **new inter-crew communication system** • **new V/UHF radios (3), and satellite-communication radio (1)** • **new multi-band directional finder (MDF)** • **VHF modernization** • **new dedicated directional command activated sonobuoy system (DICASS) radio**

Block III Mission System	• **new acoustic processing system** • **new electro optic infra-red (EO/IR) systems** • **new electronic warfare support measures (ESM)** • **new imaging radar** • **new magnetic anomaly detector (MAD)** • **new data management system (DMS)** • **new operational mission simulator (OMS)**
Block IV Upgrades	• **new defensive electronic warfare system** • **new tactical data link 16** • **new air-to-surface weapon**

TABLE 1: Aurora Incremental Modernization Projects by Block

The ASLEP proposed incorporating the changes depicted in Figure 1, ultimately extending the average life of each Aurora aircraft by 11,000 hours. Updating all 18 aircraft would extend the Aurora until at least 2025; however, this would come at an estimated cost of $25 million per aircraft or $450 million for the fleet. As part of an initial options analysis, the feasibility of joining the U.S. Navy's P-8 Poseidon Multi-purpose Maritime Aircraft (MMA) program was conducted. However, this option was rejected in 2005 as it was determined that the P-8 would not be available until at least 2020, and that it would cost significantly more than continuing with AIMP/ASLEP.[5] In October 2007, faced with insurmountable costs of AIMP and ASLEP, the government suspended the ASLEP and Block III modernization until DND's fiscal commitments could be re-examined.

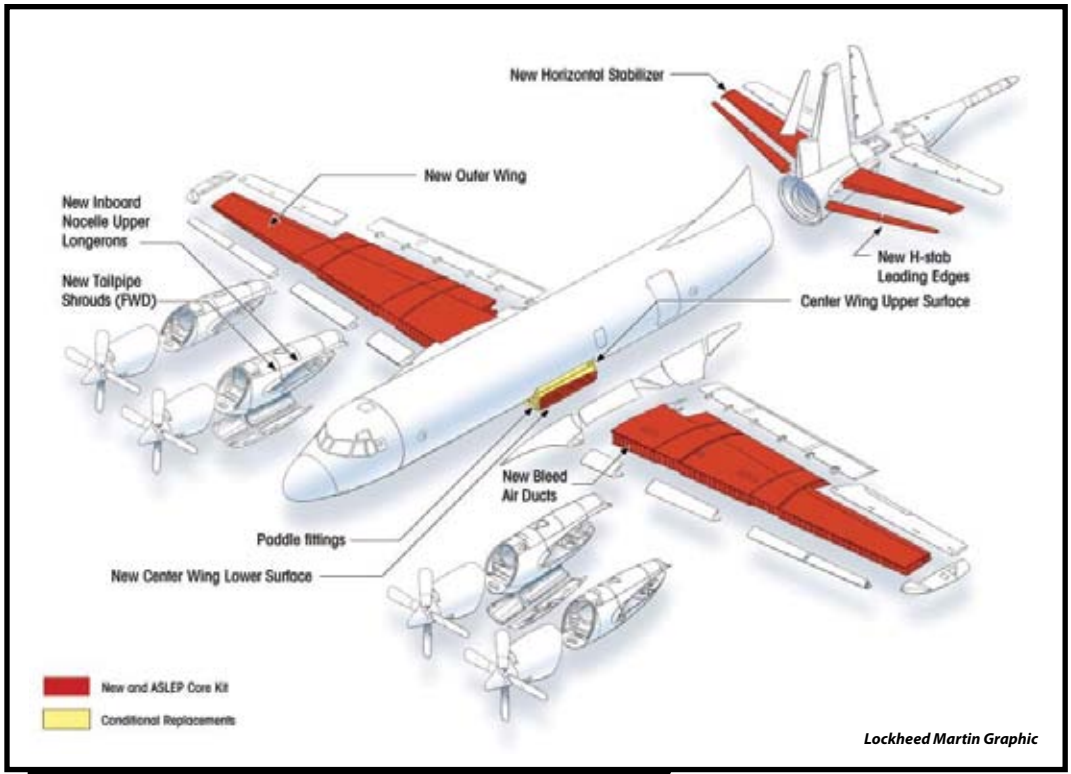

FIGURE 1: The CP140 Aurora Service Life Extension Program (ASLEP) Wing and Horizontal Stabilizer Replacement.

On 14 December 2008, the Minister of National Defence (MND) directed that 16 aircraft will receive the Block II upgrades; whereas, only 10 production aircraft will be modified to the Block III configuration and receive ASLEP. This decision means that there is the potential that Aurora will be operated in two configurations until approximately 2014 when the non-ASLEP aircraft will reach their end of life. The Block III ASLEP aircraft will continue to fly, but at reduced YFR not to exceed 6,500 hours and without third line maintenance and repair until reaching their end of life starting in 2020. In concert with this and commensurate with direction in the CFDS, a third project, the Canadian multi-mission aircraft (CMA) was identified to replace the Aurora fleet with 10–12 maritime patrol aircraft starting in 2020. "The new aircraft will become part of a surveillance 'system of systems' that will also comprise sensors, unmanned aerial vehicles and satellites and keep Canada's maritime approaches safe and secure, including the Arctic."[6]

It is generally accepted that AIMP will give the CP140 Aurora C2ISR capabilities second to no other LRP aircraft in the world. Furthermore, the ASLEP, along with investment into obsolescence replacement, additional spare parts, and ongoing third line maintenance and repair, will effectively reset the CP140's airframe life such that it could be flown to 2025 and possibly beyond. The latter is extremely dependent on the YFR and the fleet size. Ultimately, it would be prudent to determine if a fleet of 10 LRP aircraft can meet Canada's C2ISR needs before the system of systems is established.

CANADA FIRST DEFENCE STRATEGY – SITUATION REPORT

The CFDS, presented in May 2008, is different from previous white papers in that it not only delineates policy but also supports the long-term growth of the CF by ensuring real growth in the Defence budget, a 20-year capital reinvestment plan, and a newly adopted method of accrual accounting to assist in replacing or augmenting key capabilities. At the same time, the CFDS realigns the three main priorities of the CF "to deliver excellence at home, be a strong and reliable partner in the defence of North America, and project leadership abroad by making meaningful contributions to international security."[7] Like the shopping list of the HWE in 1939, the CFDS will meet these priorities with the acquisition of 17 fixed-wing search and rescue aircraft, 15 destroyers/frigates, 10–12 maritime patrol aircraft, 65 fighter aircraft, UAVs, various land force combat vehicles, the ongoing projects involving the C17 and C130J airlift procurements, Chinook helicopters, the Joint Support Ship, and the Maritime Helicopter Project, with capital investments totalling $45–50 billion. Although these capital procurements are necessary, the CF may be challenged by the specificity of quantities, cost, and prescribed timelines of the CFDS. Lieutenant-General George Macdonald (Retired) summarized it best in the executive summary of his paper *The Canada First Defence Strategy – One Year Later*:

> The existence of a small but steady increase in defence funding over the longer term is very positive for planning purposes, but the ability to meet the demand for capability with the supply of resources will remain a major challenge. Adjustments to the Strategy will certainly be required as circumstances and priorities evolve, suggesting the need for a mechanism to make modifications from time to time.[8]

As previously stated, the current plan is to operate 10 modernized ASLEP Aurora aircraft until at least 2020. It is generally accepted that the Block III Aurora will deliver a first class C2ISR capability equipped with state of the art sensors second to none. However, the question remains: will a fleet of 10 LRP aircraft have the required capacity to meet Canada's surveillance requirements?

To meet CFDS priorities and fulfill its six core missions, the Aurora must have the capacity to conduct the following three operations: domestic, contingency and deployed. Domestic operations are defined as the routine patrol of a minimum of two of Canada's three coasts at

least once per day, requiring two mission-ready aircraft. Contingency operations are defined as 24/7 operations at the furthest extent of Canada's area of responsibility for a duration of up to two weeks, requiring a minimum of four mission-ready aircraft. Deployed operations are defined as international operations consisting of two mission-ready aircraft for up to two months at a time.

CFDS SIX CORE MISSIONS

- **Conduct daily domestic and continental operations, including in the Arctic and through NORAD**
- **Support a major international event in Canada, such as the 2010 Olympics**
- **Respond to a major terrorist attack**
- **Support civilian authorities during a crisis in Canada such as a natural disaster**
- **Lead and/or conduct a major international operation for an extended period**
- **Deploy forces in response to crises elsewhere in the world for shorter periods**

Fleet size requirements can be calculated using the following equation:

$$\text{MISSION READY} = \left(\text{FLEET SIZE} - \text{AIRCRAFT IN PREVENTIVE MAINTENANCE}\right) \times \text{SERVICEABILITY RATE}$$

Rearranging the terms:

$$\text{FLEET SIZE} = \left(\text{MISSION READY} \,/\, \text{SERVICEABILITY RATE}\right) + \text{AIRCRAFT IN PREVENTIVE MAINTENANCE}$$

In determining the LRPA capacity to meet the CFDS requirement, it is difficult to project the daily demand upon the Aurora fleet based upon the frequently changing operational tempo. As such, one could evaluate the CFDS/LRPA fleet-size requirement using a goal post analogy by establishing the minimum and maximum requirements with the optimum number being somewhere in between. As a minimum, the Aurora must be able to conduct domestic operations, thus requiring two mission-ready aircraft. As a maximum, the CF may be required to respond to all three types of operations simultaneously, thus requiring a mission-ready fleet of eight aircraft. Understandably, variability exists in the frequency of preventive maintenance (periodic and third line maintenance and repair), and serviceability rate (~55%), but by using historical CP140 numbers, it can be determined that domestic operations would require a fleet size of 4.8 aircraft. To support all CFDS missions simultaneously would require a fleet size of 18.2 aircraft. Note that this calculation does not take into consideration force generation requirements. The resultant fleet size, preventative maintenance, and airframe hours remaining can be used to determine the YFR achievable. As expected, the larger the fleet size the more flexibility the CF will have to meet the CFDS missions and respond to variations in the operational tempo. Figure 2 summarizes the perceived risk of varying fleet size to meeting CFDS missions, along with the estimated YFR achievable.

The arrival of the CMA may seem some time off, but if historical procurement trends are any indication it is not too soon to begin work on its concept of operations within a surveillance system of systems. Given the variables associated with this new system of systems, the CP140 remains the only constant. The Block III Aurora's capabilities will be well known, will be operationally airworthy, and will provide the full gambit of the CF's maritime and Arctic ASW/C2ISR requirements. Extra capacity within the CP140 fleet, by way of more AIMP/ASLEP aircraft, would facilitate the option of extending the fleet, and risk mitigate for delays in either CMA or the surveillance system of systems. In addition, any extra capacity in the Aurora fleet would provide an ideal demonstration vehicle through which C2ISR systems for both CMA and UAVs could be developed and proven. As new technologies and tactics present themselves, the Aurora could be used to demonstrate and/or validate them. Furthermore, if larger issues preclude the implementation of satellite, UAV,

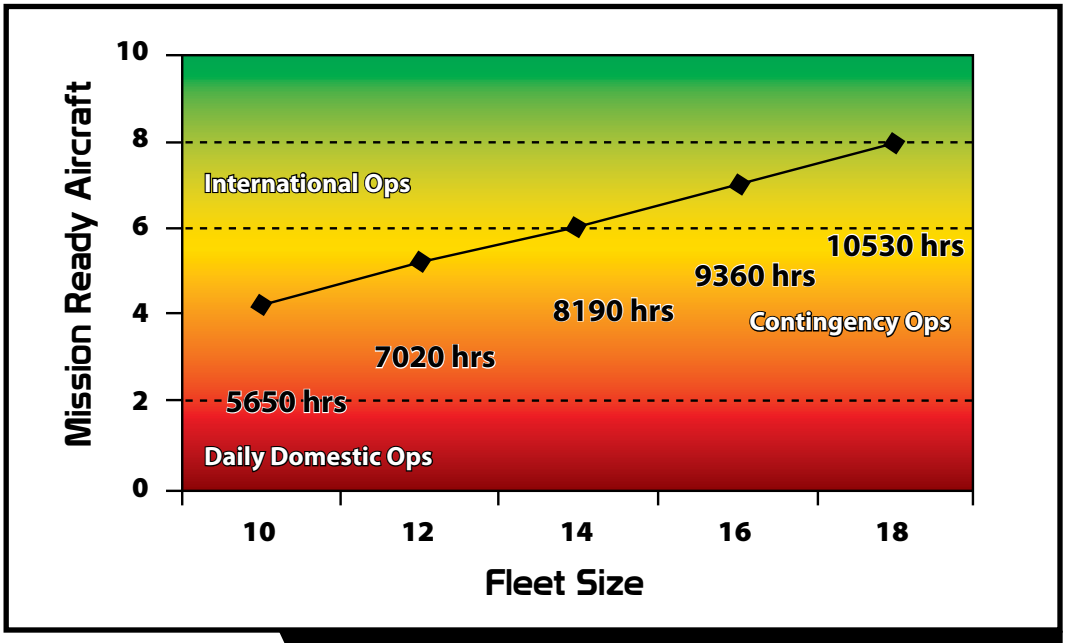

FIGURE 2: CP140 Aurora fleet size versus Canada First Defence Strategy mission requirements with overlay of achievable yearly flying rates.

or even the CMA aspects of the CF's system of systems, the option to extend the Aurora would serve to mitigate the risk of potentially widening Canada's ASW/C2ISR capability gap. The downside to all of this is that increasing the production of AIMP/ASLEP comes with the knowledge that the Aurora will need to be replaced at some point and that the CFDS budget, although significant, is not unlimited.

CP140 AURORA – OFF STATION

It is a central tenet of Air Force doctrine that "flexibility is the key to air power." For a country like Canada, that means that aircraft with multiple capabilities are essential. This tenet has rung true throughout the origins of Canada's LRPA capability in WWII to the peacetime activities of aerial photography, mapping and surveying, to today's requirement to respond to the traditional ASW and ASUW roles, to the new C2ISR roles expectant of the surveillance system of systems. AIMP brings the CP140 Aurora into the 21st century to give Canada a maritime, Arctic, and overland surveillance capability that is the best in the world. ASLEP provides the necessary improvements to make sure the Aurora can continue to deliver this capability for many years to come. The CFDS indicates that the Aurora will be replaced in 2020 with 10–12 aircraft within a surveillance system of systems. Specificity of quantities, cost, and timelines of the CFDS may present a challenge to the CF, and as such, it would be beneficial if there were a mechanism to make modifications to adjust the strategy as circumstances and priorities evolve. Ideally, the more Aurora that receive Block III and ASLEP, the more flexibility the CF will have to risk mitigate CMA and the surveillance system of systems. What is the future of the Aurora? I don't think I know just yet, but I believe there is a well established (and quite lengthy) process that does. ■

Major Graham Edwards joined the Canadian Forces in 1988, attending Collège militaire royal de Saint-Jean, then graduating from Royal Military College with a degree in Engineering and Management in 1993. After obtaining his air combat systems officer (ACSO) wings in 1994, he was posted to 407 Maritime Patrol Squadron to conduct a six-year tour on the CP140 Aurora. In 2000, he underwent an Aerospace Systems Course. Upon graduation, he was posted to 404 Marine Patrol and Training (MP&T) Squadron Advanced Training Section and then Maritime Proving and Evaluation unit (MP&EU) where he was Project Officer and Test Director for the CP140's EO/IR and Block II projects and the CU161 Sperwer tactical unmanned aerial vehicle (TUAV). In 2006, he conducted an exchange tour with 56(R) Air C2ISR Test and Evaluation Squadron, Royal Air Force Waddington, United Kingdom (UK), where he was a Trials Director on Air C2ISR systems, including the Zephyr high altitude, long endurance unmanned aerial vehicle (HALE UAV), UK airborne warning and control system and Nimrod aircraft. He was promoted to his current rank in 2007, and in 2009 posted to his current position within the Chief of Air Staff Directorate Air Requirements (CAS DAR) 3-5 in Ottawa.

List of Abbreviations		EO/IR	electro-optical infrared
AIMP	Aurora Incremental Modernization Program	ESM	electronic warfare support system
ASLEP	Aurora Service Life Extension Program	HWE	home war establishment
ASUW	anti-surface warfare	LRP	long-range patrol
ASW	anti-submarine warfare	LRPA	long-range patrol aircraft
C2ISR	command and control, intelligence, surveillance and reconnaissance	RCAF	Royal Canadian Air Force
CF	Canadian Forces	UAV	unmanned aerial vehicle
CFDS	Canada First Defence Strategy	US	United States
CMA	Canadian multi-mission aircraft	WW II	Second World War
DND	Department of National Defence	YFR	yearly flying rate

Notes

1. Juno Beach Centre, "Home Defence: The Creation of the Home War Establishment (HWE)." Available online at http://www.junobeach.org/e/4/can-tac-air-hwe-e.htm (accessed May 5, 2010).

2. Royal Canadian Air Force, "Consolidated B-24 Liberator's of the RCAF," *The Archives.* Available online at http://rcaf.com/Archives/archivesDetail.php?Consolidated-B-24-Liberator-s-of-the-RCAF-14 (accessed May 5, 2010).

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7. Ibid., 3.

8. George Macdonald, "The Canada First Defence Strategy – One Year Later," *Canadian Defence & Foreign Affairs Institute*, October 2009. Available online at http://www.cdfai.org (accessed May 5, 2010).

Photo: Sgt Eileen Redding