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RCAF Future Concepts: Air-to-Air Refuelling

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Exercise Solo Flight

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RCAF Future Concepts: Air-to-Air Refuelling

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AIR TO AIR REFUELLING; RCAF FUTURE CONCEPTS

INTRODUCTION

Since the birth of powered flight in 1848, aircraft have been limited in range and endurance by the amount of fuel available within the internal fuel tanks of each flying machine.[1] The ability to carry heavy aviation fuel is normally balanced by the desired amount of cargo and the distance required to be flown, or the time required to stay in the air for each flight. Four forces are constantly working in unison on the aircraft while it is in flight. Thrust counters drag while weight counters lift from the moment an aircraft becomes airborne until it touches down in the landing area.[2] These forces must remain balanced during the entire flight and are therefore limited in nature by the design of each aircraft. It is this delicate balancing act that the early pioneers of aviation were challenged to overcome. Many early inventors, like British inventor John Stringfellow in June 1848, and American Samuel Langley in 1896, had successfully flown self-powered aircraft that were heavier-than-air. However, the nature of steam driven engines was problematic in that they were heavy and required a hefty supply of fuel which limited the cargo capacity and therefore resulted in short duration, unmanned flights.[3] It was not until the Wright brothers used a lighter petrol-engine, that manned, heavier-than-air flight became a reality.

The limitation of weight of an aircraft is most predominant during the take-off phase of flight when the aircraft is generating limited lift, while operating at low speeds.[4]

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[1] New Scientist. “First Powered Flight.” Accessed March 14, 2022. https://www.newscientist.com/definition/first-powered-flight/

[2] MSFC, “NASA - The Four Forces of Flight.”

[3] “First Powered Flight.”

[4] MSFC, “NASA - The Four Forces of Flight.”

This deficiency had been a controlling factor for aviation until the first successful Air-to-Air refuelling (AAR) was conducted in April 1923 by Lieutenants L.H. Smith and J.P. Richter. The two pilots flew two de Havilland DH.4B bi-planes at Rockwell Field near San Diego, USA.[5] By dangling a 50-foot length of refuelling hose that was gravity fed, the world air endurance record was achieved after remaining airborne for 37 hours 15 minutes, see figure 1.

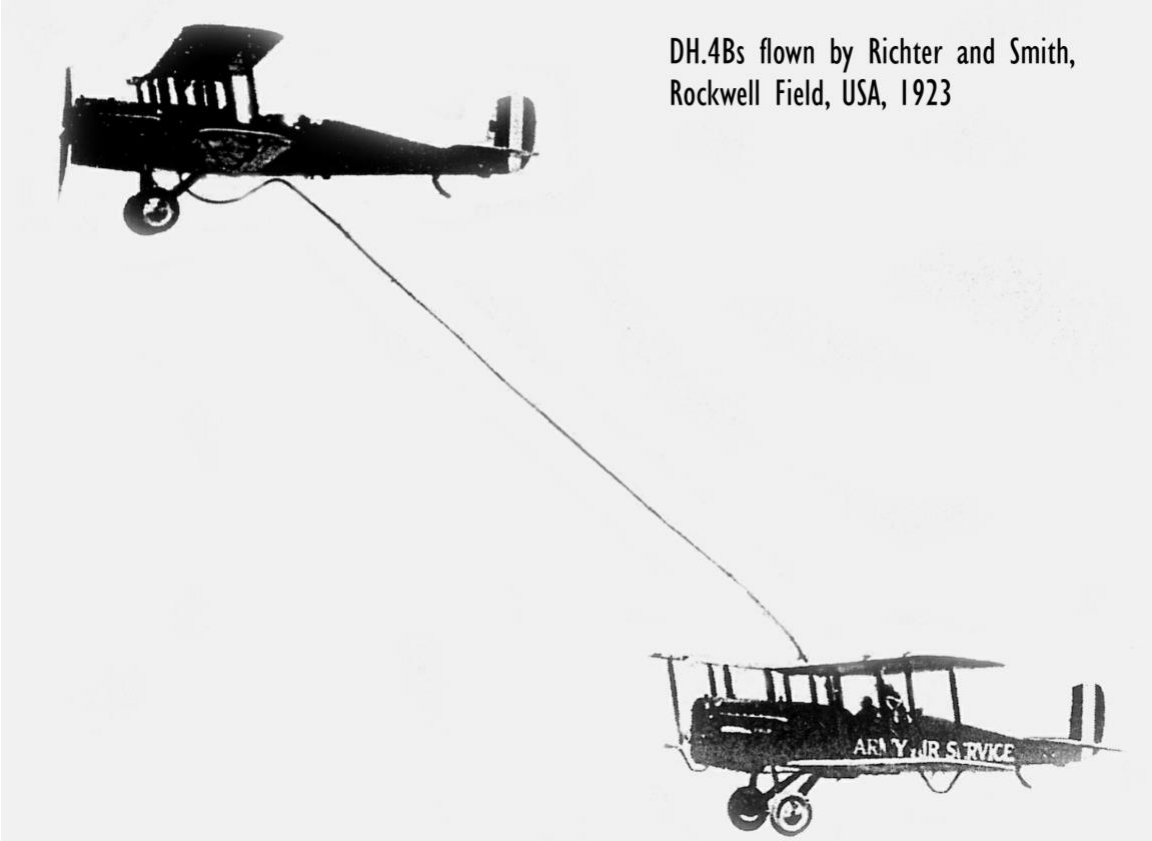

Figure 1 – Early Air to Air Refuelling

Source: Richard M. Tanner. History of Air-to-Air Refuelling. Barnsley: Pen & Sword Aviation, 2005.

[5] Richard M. Tanner, *History of Air-to-Air Refuelling*, 11.

This unprecedented achievement invigorated a global effort to improve the design and method to deliver fuel while in flight.

Today, AAR has become common place on the three-dimensional battlefield. This capability increased both range and cargo capacity for transport aircraft while reducing the time to deliver effects anywhere in the world. Additionally, fighter type aircraft benefit from increased endurance which enhances their ability to support joint operations within a Joint Operating Area (JOA). The ability to take off with larger kinetic payloads and remain airborne for longer periods with AAR support has reshaped the way modern air power is projected.

While by developing a robust AAR capability for the future, other Royal Canadian Air Force (RCAF) capabilities may be sacrificed, and if not fully committed, the RCAF risks not having the necessary options to offer to future coalition campaigns. The force multiplier effect that AAR offers to modern air warfare is undeniable. Canada must develop a wide-ranging AAR capability to provide to future alliance missions that involve expeditionary multinational operations as well as to ensure national sovereignty of the North as global warming opens access to the Arctic. The geographic nature of Canada requires RCAF aircraft to operate for long distances over areas with limited ground refuelling options. Additionally, the Canadian Armed Forces (CAF) ability to remain relevant on the world stage during international operations will be strengthened with an organic, dependable RCAF AAR contribution. A comprehensive well defined AAR expertise will enhance Canada's contribution to international alliances including

North Atlantic Treaty Organization (NATO), North American Aerospace Defense Command (NORAD) and the United Nations (UN).

By analysing Canada's historical development of a small fledgling AAR capability this paper will leverage lessons learned and apply them to future concepts. An understanding of the NATO and NORAD current and future demands for airborne refuelling will shape a niche capability that the CAF can provide on behalf of Canada as a Whole-of-Government response to future conflicts. Finally, a look forward to the investment of modern heavy airlift tanker aircraft, with the focus to develop a truly Canadian comprehensive capability, which will become the cornerstone of Canada's commitment and contribution to future expeditionary air operations.

THE CONCEPTION AND REFINEMENT OF CANADIAN AAR

Canada's first AAR capable aircraft was the Boeing 707-347C which became fully operational in May 1972.[6] Two of these aircraft were modified shortly after acquisition to be able to deliver fuel to fighter aircraft via the probe and drogue system, see Figure 2. This initial AAR platform was purchased as a primary means to support the CF-5 Freedom Fighter while conducting NATO operations in Europe and Scandinavia. In 1973 the new Boeing 707 tanker conducted the first oceanic escort of four CF-5 fighters. Exercise *Long leap I* was a non-stop ferry flight from Canadian Force Base (CFB) Bagotville to Norway.[7] Without the support of AAR the CF-5 fleet, in previous deployments, required days to hop from island to island across the North Atlantic region.[8]

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[6] Stachiw and Tattersall, *Boeing CC137: 707-347C*, 2:19.

[7] Stouffer, "COLD WAR AIR POWER CHOICES FOR THE RCAF: PAUL HELLYER AND THE SELECTION OF THE CF-5 FREEDOM FIGHTER."

[8] *Ibid*.

The high value of AAR was recognized immediately following the conception of Canada's airborne refuelling mission capability.

Figure 2 – RCAF Boeing 707 refuels a CF5 Freedom Fighter

Source: DND Photo via James Craik, https://www.silverhawkauthor.com/post/canadian-warplanes-6-jets-boeing-cc-137-husky-boeing-707-320c

The CF-5 was eventually replaced by the CF-188 Hornet in the early 1980's.[9] The CF-188 was supported by the Boeing 707 tankers during many international deployments during its first decade of service. Over the years, the strategic Boeing 707 tankers also supported aircraft from many partner nations and proved to be extremely effective during the Gulf War in 1991.[10] The Boeing 707 was retired after 25 years of successful AAR service, in April 1997.

The NATO air campaign over the Federal Republic of Yugoslavia between March and June 1999 highlighted the importance of Strategic AAR to the deployment of fighter assets conducting expeditionary operations. At the peak of the campaign, Canada

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[9] "McDonnell Douglas CF-18 Hornet."

[10] Dowsett, Patrick, "652-The-Restoration-of-Canada's-Air-Refuelling-Capability| FrontLine Defence."

deployed 18 CF-188's to Aviano, Italy.[11] Although Canada retained a small tactical AAR CC-130T Hercules capability during this period, the CAF relied heavily on Strategic AAR provided by the USAF to deploy the Hornets to Italy.[12]

This RCAF capability gap would eventually be relieved by the conversion of two Airbus 310-304 (a.k.a. CC-150 Polaris) aircraft into Multi Role Tanker Transport (MRTT) configuration, which went into service in the fall of 2004.[13] These aircraft played a pivotal role during Operation *Unified Protector* (OUP) which established a no-fly zone over Libya during the Libyan civil war in 2011. While implementing United Nations Security Council Resolution 1973, coalition fighter forces relied heavily on AAR due to the large distances between bases in the southern Mediterranean region and Libyan airspace.[14] The two CC-150 Polaris MRTTs based in Trapani, Italy delivered 14 million pounds of fuel during the conflict accounting for 4.1 percent of all NATO refuelling missions.[15]

RCAF Historian Dr. Richard Mayne acknowledges a key to the RCAF's success during OUP can be attributed to "…it's high level of air-to-air integration and interoperability, as was demonstrated through the CC-150's and CC-130's ability to provide fuel to almost every coalition nation…."[16] The large AAR contribution by the relatively small RCAF during OUP highlights the deficiency of NATO's ability to provide tanker support to kinetic air operations. It also proves the ability of Canada, when

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[11] Defence, "Operation ECHO."
[12] English and University of Manitoba. Centre for Defence and Security Studies, *Canadian Expeditionary Air Forces*, 5:49.
[13] "Airbus A310 MRTT Multi-Role Tanker Transport."
[14] "Security Council Resolution 1973 - UNSCR," 19.
[15] Mayne, "The Canadian Experience," 258.
[16] *Ibid*, 265.

fully committed, to exceed expectations and provide a vital combat support capability to coalition air campaigns.

AAR EMPLOYED IN NATO AND NORAD

Air-to-air tankers transfer aviation fuel to receiver aircraft while inflight, using two types of systems. The flying boom system requires a dedicated boom operator who flies the boom into position before the two aircraft make contact. This system allows for larger fuel transfer rates and is the most common choice for modern fighter aircraft as well as larger cargo type aircraft that require large quantities of aviation fuel, see figure 3.

Courtesy Netherlands Institute for Military History; photo by H. Keeris

Figure 3 – Royal Netherlands KC10 refuels a F16 using the Boom System

Source: Anrig, Christian F. and Air University (U.S.). *The Quest for Relevant Air Power: Continental European Responses to the Air Power Challenges of the Post-Cold War Era*. Book, Whole. Maxwell Air Force Base, Ala: Air University Press, Air Force Research Institute, 2011. https://go.exlibris.link/BW5SfxCn.

The second type of transfer system, the probe and drogue, is less complicated and requires minimal guidance by the tanker crew. However, this system provides a reduced transfer rate and is therefore best suited to small fighter type receivers who do not require

large quantities of fuel. This system is currently in use on the CC-150 MRTT, see figure 4.

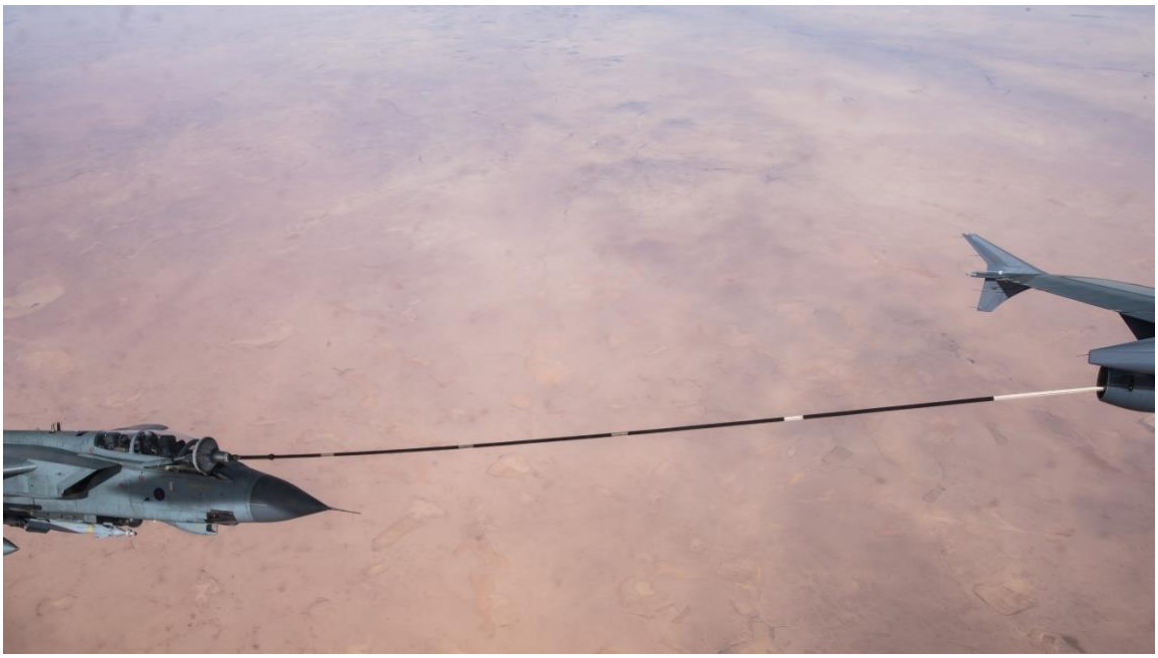

Figure 4 - A CC-150 Polaris Airbus refuels a Royal British Air Force GR4 Tornado during Operation IMPACT on February 2, 2015.

Source: Canadian Forces Combat Camera, DND IS01-2015-0002-008

In 2006, European Defence Ministers formally acknowledged an air-tanking capability gap amongst European NATO members while meeting at Royal Air Force (RAF) Lyneham (UK).[17] This gap is attributed to the fact that most European nations, during the Cold War, worked under the assumption that future conflicts would permit them to operate close to their operating bases, thus negating the need of AAR support.[18] Current NATO policy describes the requirement for each member nation to provide

[17] "Filling Air-to-Air Refuelling Gap."

[18] JOINT AIR POWER COMPETENCE CENTRE KALKAR (GERMANY), "Air-to-Air Refueling Flight Plan; An assessment". February 2011

individual training, maintenance and deployment of their own forces into the JOA.[19] In reality, many smaller NATO member Air Forces do not have an organic AAR capability and therefore rely on partner nations during expeditionary operations, similar to how Canada deployed the Hornets to Yugoslavia in 1999. As NATO continues to operate in a more expeditionary way, the critical force multiplier nature of AAR plays an ever-increasing role in modern joint operations.

Interoperability amongst member forces is pivotal to successful rapid deployments. Each tanker must be certified to operate with each receiver by means of bilateral Memoranda of Understanding (MOU).[20] Procedures and compatibility issues complicate a multinational expeditionary force deployment. For example, a boom type receiver cannot be serviced by a probe and drogue equipped tanker. NATO does not operate AAR assets on its own and relies completely on nations like the United States (US) who have large tanker fleets.

However, the United States Air Force (USAF) is in the process of replacing the 400 aging KC-135 tankers with 179 new KC-46 Pegasus tankers.[21] This reduction in fleet size will increase pressure on other NATO partners in future deployments as certifications to support multiple NATO receivers will take time and the requirement to develop new MOUs will hinder future just-in-time interoperability. The RCAF has already proved it is capable of rapidly certifying receivers including non-NATO platforms, such as the Swedish Air Force JAS-39 Gripen, as demonstrated during OUP.[22]

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[19] JOINT AIR POWER COMPETENCE CENTRE KALKAR (GERMANY), 1.
[20] *Ibid*,2.
[21] "Boeing."
[22] Mayne, "The Canadian Experience.", 258.

Several European countries (Germany, France, Italy, the Netherlands, Spain, and the UK) have been participating in an AAR sharing agreement, coordinated through the Movement Control Centre Europe in Eindhoven, NL.[23] This partnership is external to NATO and designed to facilitate the efficient use of AAR assets during peacetime operations.[24] Therefore, it does not improve NATO's combat capabilities as a combined whole fighting force.

Canada's commitment to NORAD includes quick reaction fighter and tanker capabilities.[25] The CF-188 has been supported by the CC130 Hercules tanker while deployed to the northern forward operating bases in the high Arctic. Canada has not committed the Polaris CC-150 MRTT to NORAD as a rapid reaction asset due to the inability of the two airframes to maintain a constant standby posture. [26] The CC-150 MRTT aircraft are limited in numbers and regularly support expeditionary deployments as strategic airlift elements. Therefore, Canada continues to rely on the USAF to support strategic tanker requirements while completing the NORAD mission.[27] The development of a robust Canadian AAR capability with at least ten tankers would alleviate the reliance on the USAF during NORAD response to unapproved Canadian Air Defence Identification Zone penetration by foreign aircraft.[28] A fleet of tankers combined with modern fighter platforms would allow the RCAF to independently defend the Northern approach to Canada.

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[23] "JAPCC_AAR_Flight_Plan_web.Pdf."
[24] *Ibid*, 5.
[25] Defence, "NORAD."
[26] Latwaitis, "The Challenges of Air-to-Air Refuelling and Search and Rescue Support to Arctic Fighter Operations," 4.
[27] *Ibid*, 3.
[28] Defence, "Canadian Air Defence Identification Zone Now Aligned with Canada's Sovereign Airspace."

Dr. Richard Goette proposes the RCAF could become niche in several disciplines including AAR, training, air-advisory, personnel, jointness, targeting, expeditionary, and ISR.[29] He suggests the negative aspect of becoming a niche air force is that it limits the ability to contribute to a coalition as the RCAF would then no longer be as balanced as it is today.[30] However, with diminishing AAR assets in the USAF, as the KC-135 is decommissioned, as well as recognized shortages across NATO, a RCAF specific AAR capability will be very much be in high demand during future coalition long range activities.

THE FUTURE CANADIAN MRTT CAPABILITY

The CAF is actively pursuing a next generation strategic AAR and long-range strategic transport capability, as directed in Canada's current defence Policy; Strong, Secure, Engaged.[31] Air Force Vectors holds the broad guidance of what the future of the RCAF should look like. It describes a need to be "interoperable at all levels with the USAF and, thus, other US forces; other key allied Air Forces…."[32] As the USAF transitions its front-line fighter to the F-35 it is imperative that Canada acquires an AAR asset that utilizes a boom type of fuel transfer system that supports this fifth-generation fighter. Additionally, these tanker platforms will need to be equipped with sensors and low probability of intercept datalinks to support future combat cloud networks.[33]

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[29] Goette, *Preparing the RCAF for the Future,* p.33.
[30] *Ibid*, 33.
[31] *Strong Secure Engaged*, 39.
[32] *Air Force Vectors*, 8.
[33] Layton, "Fifth-Generation Air Warfare," 28.

The current project to replace the CC-150 Polaris is known as the Strategic Tanker Transport Capability (STTC).[34] The project is currently in phase three of the acquisition process and has identified Airbus Defence and Space SA as the only company that meets the requirements described in the Invitation to Qualify.[35] This would indicate that the Airbus 330 MRTT is possibly the replacement for the Airbus 310 MRTT.[36] This is an opportunity for the RCAF to establish an all encompassing AAR capability. Airbus offers the ability to equip the A-330 with both the probe and drogue as well as the boom type system.[37] In order to develop a RCAF AAR system that would provide maximum contribution to alliance operations this option must be considered. By employing this configuration, the RCAF will be able to simultaneously provide fuel to every fast air receiver as well as cargo aircraft currently operating in NATO and NORAD.[38]

Diverse tanking receiver options would include the CC-177 Globemaster III that the RCAF operates from 8 Wing Trenton.[39] These Canadian aircraft have the necessary plumbing and hardware to receive fuel via a boom type system. The ability to provide consistent, reliable AAR support to Canada's strategic airlift fleet will alter the way the RCAF conducts long range operations. The extended reach of strategic airlift will benefit the UN during future responses to natural disasters and other humanitarian assistance missions. For example, the distance between 8 Wing Trenton and Djibouti in eastern Africa is 6173 nm, see figure 5.[40]

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[34] Defence, "Strategic Tanker Transport Capability Project."
[35] Defence, "Strategic Tanker Transport Capability Project."
[36] "Airbus, Boeing Tankers Jockey to Replace Polaris."
[37] "A330 MRTT | Airbus."
[38] *Ibid*.
[39] "Boeing C-17 Globemaster III."
[40] "Great Circle Mapper ✓ Flight Distance ✓ Flight Time ✓ Aviation Database."

Figure 5 – Great Circle Route - 8 Wing Trenton - Djibouti Intl, Djibouti.

Source: "Great Circle Map." Accessed April 10, 2022. https://www.greatcirclemap.com/?routes=HDAM-CYTR.

The flight time at Mach 0.74, the typical cruising speed of the CC-177, would indicate a 13.7-hour flight assuming zero tailwind.[41] This hypothetical mission is beyond the range of a fully loaded aircraft and would require an enroute refuelling stop that would extend the mission to beyond the normal maximum crew duty day of 14 hours.[42] The required crew rest at the enroute refuelling airport would extend the deployment mission length. The same restrictions during the return leg would dictate a minimum five-day itinerary to deliver one load of humanitarian support. However, the addition of AAR somewhere along the route would allow for increased cargo capacities at the initial take-off location as well as direct delivery in one day. The entire mission including both deploy and redeploy would be reduced to three days and the increased cargo capacity would reduce the total number of cargo flights from Canada.

As Toydas and Malyemez suggest with air refuelling, the added airborne tanker support can be offset by a savings in total fuel due to the reduced number of cargo flights

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[41] "Boeing C-17 Globemaster III."
[42] Defence, Flight Crew Operating Manual, 1 Canadian Air Division.

resulting in an overall reduced carbon footprint to the entire deployment.[43] Deployment timing will be significantly reduced allowing for a rapid and concise response by the CAF on behalf of the Government of Canada to future UN humanitarian assistance resolutions.

The ability of the CC-177 to receive large amount of fuel airborne will also reshape the way Canada manages resupply to its Northern outposts. Canadian Forces Station (CFS) Alert, located on the northern tip of Ellesmere Island at a latitude of 82°30'05" North which places it 817 kilometers from the geographic North Pole, see figure 6.

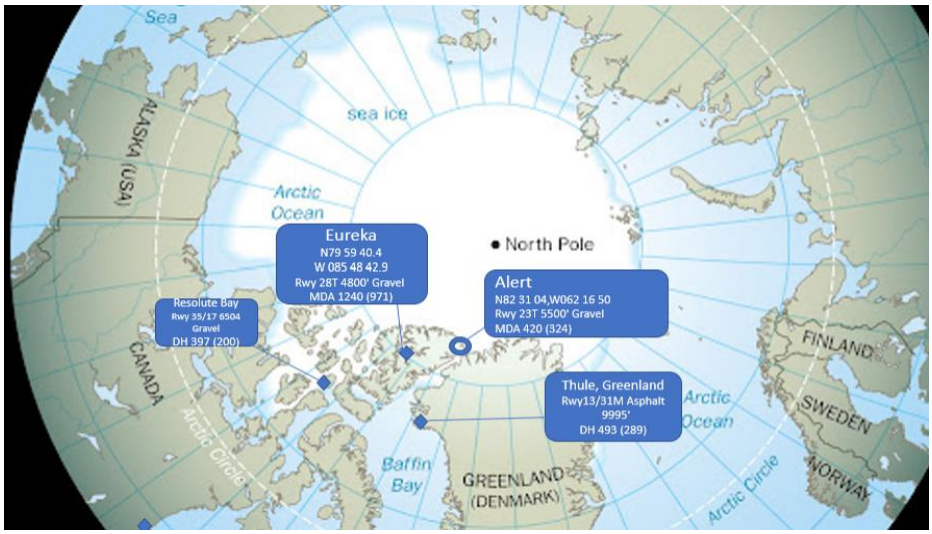

Figure 6 – Geographical Location of High Arctic Bases

Source: ADMIN. n.d. 'Arctic and North Pole Map'. *SWmaps.Com* (blog).

Annually, CFS Alert consumes approximately 2,000,000 liters of fuel to generate electricity and heating.[44] The station uses four cogeneration units that burn DF-8 fuel that

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[43] Toydas and Malyemez, "Air Refueling Optimisation for More Agile and Efficient Military Deployment Operations."

[44] Kegel et al., *Power and Energy Conservation in the Arctic: A Case Study on the Canadian Forces Station Alert*, 2542.

is delivered primarily during the two-week, 24-hour Op *Boxtop*. In recent years, this amounts to approximately 2,486,000 liters of DF-8 and diesel fuel to be delivered during the bi-annual expeditionary operation.[45] Depending on weather and alternate airport requirements, a CC-177 normally has been able to deliver up to 50,000 liters of fuel each flight.[46] The two-week deployment to Thule, Greenland during Op *Boxtop* will no longer be required as the combined power of strategic airlift and strategic AAR will be able to satisfy the station's fuel demands during the weekly resupply flights conducted throughout the year.[47] This approach can be leveraged to other communities in the high Arctic that are completely dependant on airlift as the only option for logistical support. The ability to increase the RCAF presence in the northern latitudes will reinforce Canada's claim of sovereignty as the Northwest Passage continues to open as a result of global warming.[48]

CONCLUSION

Canada's mission statement for its strategic tanker capability has not changed since the conception of Canadian Strategic AAR.[49] Firstly, to be able to deploy four fighters to the European region non-stop with the assistance of one airborne refueler conducting a ferry-escort type mission. Additionally, to be able to provide AAR support to our fighters as well as coalition fighters operating in a Joint Operating Area (JOA) who are conducting combat operations.[50] With the advancement in AAR across multiple

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[45] Cote, George. Re: BOXTOP RFI, received by Maj James Fedevich. Email Responses 2021.
[46] *Ibid*.
[47] Lajeunesse, Lackenbauer, and Gregg Centre for the Study of War and Society, *Canadian Armed Forces Arctic Operations, 1941-2015: Lessons Learned, Lost, and Relearned*. p.273.
[48] Leddy, Jul 07, and 2020, "China's Arctic Endgame."
[49] Defence, "Procurement – Air."
[50] "652-The-Restoration-of-Canada's-Air-Refuelling-Capability| FrontLine Defence."

platforms the RCAF mission statement should be expanded to incorporate NATO AAR ATP-56(B) standards to ensure interoperability for Canada's new tanker capability.[51]

By leveraging recent successful RCAF AAR deployments with limited tanker aircraft, Canada must acquire a generous amount of next generation tankers to be able to increase its contribution to future NATO expeditionary operations. At the same time, Canada will be able to enhance its ability to project power to the Arctic regions. The development of a robust modern AAR capability, which supports fifth generation fighter aircraft, will also facilitate Canada's continued interoperability within NORAD.[52]

Finally, Canada must re-enforce its ability to operate in expeditionary mission profiles, which have increased in recent history. The US is shifting its focus from the Middle East to the Indo-Pacific region. [53] The development of the Pacific Deterrence Initiative will result in large transit routes from North America to the South Pacific. Future deployments will rely heavily on AAR to transit the vast Pacific oceanic airspace. By obtaining a tailored fleet of AAR aircraft Canada will be positioned to be the support mechanism and facilitator of future coalition, long range efforts in the Southern Hemisphere.

Canada has a proud history of being a leader in aviation which commenced in 1939 with the British Commonwealth Air Training Plan.[54] By developing a uniquely Canadian ability to deliver fuel airborne, Canada has an opportunity to expand on its

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[51] "JAPCC_AAR_Flight_Plan_web.Pdf," 27.

[52] *Air Force Vectors*.

[53] Congressional Research Service, "Renewed Great Power Competition: Implementations for Defense-Issues for Congress, Mar 10, 2022. P.16.

[54] Government of Canada, "British Commonwealth Air Training Plan | Royal Canadian Air Force."

impressive aviation heritage while satisfying future domestic and international operations that will most definitely involve some level of the force multiplier known as Air-to-Air Refuelling.

BIBLIOGRAPHY

"652-The-Restoration-of-Canada's-Air-Refuelling-Capability| FrontLine Defence." Accessed March 15, 2022. https://defence.frontline.online/article/2004/2/652-The-Restoration-of-Canada%E2%80%99s-Air-Refuelling-Capability.

"Airbus A310 MRTT." In *Wikipedia*, January 8, 2022. https://en.wikipedia.org/w/index.php?title=Airbus_A310_MRTT&oldid=1064471731 Page Version ID: 1064471731.

Airforce Technology. "Airbus A310 MRTT Multi-Role Tanker Transport." Accessed March 15, 2022. https://www.airforce-technology.com/projects/mrtt/.

Air Force Vectors. Book, Whole. National Defence and the Canadian Forces, 2014. https://go.exlibris.link/xd1khw55.

"Boeing C-17 Globemaster III." In *Wikipedia*, April 8, 2022. https://en.wikipedia.org/w/index.php?title=Boeing_C-17_Globemaster_III&oldid=1081546447 Page Version ID: 1081546447.

"Boeing: C-17 Globemaster III." Accessed April 27, 2022. https://www.boeing.com/defense/c-17-globemaster-iii/.

"Boeing CC137 : (707-347C)." Accessed March 14, 2022. https://cfcc.ent.sirsidynix.net/client/en_GB/cfc/search/detailnonmodal/ent:$002f$002fSD_ILS$002f0$002fSD_ILS:61931/ada.

"Boeing: KC-46 Pegasus: USAF Multirole Refueling Tanker." Accessed March 19, 2022. https://www.boeing.com/defense/kc-46a-pegasus-tanker/.

"British Commonwealth Air Training Plan | Royal Canadian Air Force." Accessed March 20, 2022. http://www.rcaf-arc.forces.gc.ca/en/history-heritage/british-commonwealth-air-training-plan/index.page.

Clodfelter, Mark. "Theory, Implementation, and the Future of Airpower." *Air & Space Power Journal* 28, no. 5 (October 2014): 118–27.

———. "Theory, Implementation, and the Future of Airpower." *Air & Space Power Journal* 28, no. 5 (October 2014): 118–27.

Defence, National. "NORAD." Navigation page, March 11, 2021. https://www.canada.ca/en/department-national-defence/corporate/reports-publications/transition-materials/caf-operations-activities/2020/03/caf-ops-activities/norad.html Last Modified: 2021-09-30.

———. “Operation ECHO.” Education and awareness, July 22, 2013. https://www.canada.ca/en/department-national-defence/services/operations/military-operations/recently-completed/operation-echo.html Last Modified: 2013-09-20.

———. “Procurement – Air.” Navigation page, July 8, 2020. https://www.canada.ca/en/department-national-defence/corporate/reports-publications/proactive-disclosure/supplementary-budget-b-2019-2020/other-issues/procurement-air.html Last Modified: 2020-07-08.

———. “Strategic Tanker Transport Capability Project,” December 18, 2020. https://www.canada.ca/en/department-national-defence/services/procurement/strategic-tanker-transport-capability-project.html Last Modified: 2021-12-22.

———. “Canadian Air Defence Identification Zone Now Aligned with Canada’s Sovereign Airspace.” News releases, May 24, 2018. https://www.canada.ca/en/department-national-defence/news/2018/05/canadian-air-defence-identification-zone-now-aligned-with-canadas-sovereign-airspace.html Last Modified: 2018-05-24.

English, Allan D. and University of Manitoba. Centre for Defence and Security Studies. *Canadian Expeditionary Air Forces*. Vol. 5. Book, Whole. Winnipeg, Man: Centre for Defence and Security Studies, University of Manitoba, 2004. http://cfc.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwbV1NSwMxEB2KXgQPFZX6yRa8dptsUjfpUWutYC_Wi16WbJKFQl2hKNh_78y0C0V7CZsQshvYzLxJ5r0AqCwVvT82QToljPUIF0odFaksIawwOkRvlTXRMptMT9_zl6l5a8F3Q9-uvE_R-KYcwodVPf_hiN0viCzYj3XxeEedGn73Ou0S4-aPz-AWdDfH8AaXfMXFbFQ8Pc_4UWw1DAfmVsq-C4SyLOIFoqVkdB0UK9koJbXcKPU0deKy4Fu3HNG4DXtETjiCVqyPodtICySk0x84-cotV4mbLxPEomgBTqAzfni9n_RwnGKzU1Pwl2SncOgou73-YhZc6EAitEdH7q0xpUMHIkwl8txmbkDHcmVenkH73zjnO9ou4GCdeUJbCJewX-EvHq94Mtc861_QlHcF.

“Filling Air-to-Air Refuelling Gap.” *Aircraft Engineering and Aerospace Technology* 78, no. 2 (January 1, 2006). https://doi.org/10.1108/aeat.2006.12778baf.006.

“Future Concepts Directive Part 2:The Future Air Operating Concept,” n.d., 39.

Goette, Richard Evan. *Preparing the RCAF for the Future*. Book, Whole. National Defence, 2020. http://cfc.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwfV3dS8MwED-GfREEFR1-Teof0Nl8NGkfZ2dRYSDDl_kysstVBK0wt__fJLQyhvPxCFyO43L5HbnfBUDwYZps5YSc1RkyrozhwmLtQAPHgihXzDCJiyywyeTkVU8n-awHcUeNsfTdtr6juX0cuzPu8UDmcm7EZa5cGEeju9n4qQsh6Z-JXAXi6y-lUsELBynaOTud7KeLIH1sXCPVIZTdjljj8N1-_pKht6Yz_mfUEUTkGQrH0KPmBG6el-R_EmzeYofl4mk5qmIHRINQhYEhpzCo7l_Kh8SZM7dfuA6stnmnT_ThwPg-92YV-HD2zHci0UIrRkoVQmYsN8xoralGJTQnq86h_7eyi10Ll7DPfQ2ZsoQXV7C3Wq5p4DxU43Xr3B8Z2nt6.

Government of Canada, Department of National Defence, and National Defence Government of Canada. "Cold War Air Power Choices For The RCAF: Paul Hellyer and the Selection of the CF5 Freedom Fighter." Government of Canada, National Defence, Canadian Defence Academy. Accessed March 14, 2022. http://www.journal.forces.gc.ca/vo7/no3/stouffer-eng.asp.

"Great Circle Map." Accessed April 10, 2022. https://www.greatcirclemap.com/?routes=HDAM-CYTR.

Great Circle Mapper ✓ Flight Distance ✓ Flight Time ✓ Aviation Database. Accessed March 24, 2022. http://www.greatcirclemapper.net.

"History of Air-to-Air Refuelling." Accessed March 14, 2022. https://web-p-ebscohost-com.cfc.idm.oclc.org/ehost/ebookviewer/ebook/bmxlYmtfXzg0MDc3M19fQU41?sid=33ec3b86-287e-4b45-9251-d7ae90daa62c@redis&vid=0&format=EB&rid=1.

"Impact on the SIOP [Single Integrated Operational Plan] If SAC [Strategic Air Command] KC-135 Tankers Are Utilized to Support Tactical Fighter Squadron Augmentation for Phase III and IV of CINCPAC [Commander-in-Chief, Pacific Command] OPLAN 32-64 (As Augmented)," May 30, 1964. http://www.proquest.com/docview/1679163830/abstract/D64CFC7324A647B0PQ/1.

"Janes: Airbus Solely Qualifies for Canada's Tanker Procurement." Accessed February 21, 2022. https://customer-janes-com.cfc.idm.oclc.org/DefenceWeekly/DisplayFile/FG_3933580?edition=2021.

"Janes: Future Warfare: Shaping Capability for the 21st Century Battlespace." Accessed February 23, 2022. https://customer-janes-com.cfc.idm.oclc.org/DefenceWeekly/DisplayFile/FG_3780559?edition=2020.

JOINT AIR POWER COMPETENCE CENTRE KALKAR (GERMANY). "Future of Air-to-Air Refueling in NATO," no. Generic (2007). https://go.exlibris.link/K26lyNfx.

Latwaitis, Maj S G. "The Challenges of Air-to-Air Refuelling and Search and Rescue Support to Arctic Fighter Operations," n.d., 13.

Layton, Peter. "Fifth-Generation Air Warfare." *Australian Defence Force Journal*, no. 204 (n.d.): 23–32. https://doi.org/10.3316/informit.549758575008653.

Leddy, Laura, Devin Lurie on Jul 07, and 2020. "China's Arctic Endgame." American Security Project. Accessed April 27, 2022. https://www.americansecurityproject.org/chinas-arctic-endgame/.

Mayne, Richard O. "The Canadian Experience: Operation Mobile." In *Precision and Purpose*, edited by Richard O. Mayne, Karl P. Mueller, Gregory Alegi, Christian F. Anrig, Christopher S. Chivvis, Robert Egnell, Christina Goulter, et al., 239–66. Airpower in the Libyan Civil War. RAND Corporation, 2015. https://www.jstor.org/stable/10.7249/j.ctt16f8d7x.15.

"McDonnell Douglas CF-18 Hornet." In *Wikipedia*, April 1, 2022. https://en.wikipedia.org/w/index.php?title=McDonnell_Douglas_CF-18_Hornet&oldid=1080458236
Page Version ID: 1080458236.

MSFC, Kathy Forsythe: "NASA - The Four Forces of Flight." Feature Articles. Brian Dunbar. Accessed March 14, 2022. https://www.nasa.gov/audience/foreducators/k-4/features/F_Four_Forces_of_Flight.html.

National Museum of the United States Air Force™. "First Air-to-Air Refueling." Accessed March 14, 2022. https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/197385/first-air-to-air-refueling/.

New Scientist. "First Powered Flight." Accessed March 14, 2022. https://www.newscientist.com/definition/first-powered-flight/.

"FIRST POWERED FLIGHT, FIRST FLIGHT, FIRST POWDERED FLIGHT, PLANE TRUTH, FLYING INTO HISTORY." Accessed March 15, 2022. https://people.idsia.ch/~juergen/planetruth.html.

North Atlantic Treaty Organization and Joint Air Power Competence Centre. "The Journal of the JAPCC." Kalkar, Germany: Joint Air Power Competence Centre, 2005. https://go.exlibris.link/WdCHkxnh

Olsen, John Andreas. *Global Air Power*. Potomac Books, Inc., 2011
Google-Books-ID: _QYK_LihPWUC.

"Operation Unified Protector." In *Wikipedia*, March 10, 2022. https://en.wikipedia.org/w/index.php?title=Operation_Unified_Protector&oldid=1076269116 Page Version ID: 1076269116.

Richard M. Tanner. *History of Air-to-Air Refuelling*. Barnsley: Pen & Sword Aviation, 2005. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=840773&site=ehost-live&scope=site.

"Security Council Resolution 1973 - UNSCR." Accessed March 17, 2022. http://unscr.com/en/resolutions/1973.

Stachiw, A. L., and Andrew Tattersall. *Boeing CC137: 707-347C*. Vol. 2. Book, Whole. St. Catharines, Ont: Vanwell, 2004.

http://cfc.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwbV1LS8NAEB6KXkQP9UV8koN4a7rZZJukx0ZbhcaD9aKXsNkHCDUFqWD_vTObBIp6WXaHZR8wuzvfMt8MQMQDNvh1JwguLNMi04lCjalYbJnRVZpUqTSqSeYwn8XFW_JcpK89-Oro21apAC_fwEF4vanfvx1iV0siCw5NXc4m1Knjdzdul4ibP1ZaLik3x_gGj7x1xeKufJwvXJVtCcYIIaJwKDVZWRnaC0RL4ZQOiqwJtBCSLGtjQ3VtCjGIs249RNM-7BA54RB6pj4Cr3Ahtj83_q3_JFFl_PakHsP-ZGXwUfLzPIySE_Cm9y_5wwBHK9v_mtKth5_CgSQf93rtuHDaAz8TCD60VUYZHY90KoUOw5ENLYIqYTg_g_6fcc7_kV3AXuN_Qh8Jl7BrUdHNldvStdv7DxDAeEc.

Stouffer, Ray. “COLD WAR AIR POWER CHOICES FOR THE RCAF: PAUL HELLYER AND THE SELECTION OF THE CF-5 FREEDOM FIGHTER.” *Canadian Military Journal (Ottawa)* 7, no. 3 (2006): 63.

Strong Secure Engaged. Book, Whole. National Defence, 2017. https://go.exlibris.link/mRP5pkf9.

“The Future of Canadian Strategic Tankers.” Accessed February 21, 2022. https://cfcc.ent.sirsidynix.net/client/en_GB/cfc/search/detailnonmodal/ent:$002f$002fSD_ILS$002f0$002fSD_ILS:71431/ada.

Toydas, M., and C. Malyemez. “Air Refueling Optimisation for More Agile and Efficient Military Deployment Operations.” *The Aeronautical Journal* 126, no. 1296 (2022): 365–80. https://doi.org/10.1017/aer.2021.69.*New York Times* null, no. null (2003): null.