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THE BACKBONE OF REACH & POWER: AIR-TO-AIR REFUELING IN THE RCAF

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THE BACKBONE OF REACH & POWER: AIR-TO-AIR REFUELING IN THE RCAF

By LCol S. Lamarche

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LIST OF ABBREVIATIONS

AAR	Air-to-Air Refueling
ACF	Aerospace Capability Framework
AFV	Air Force Vectors
ALCM	Air Launched Cruise Missiles
AO	Area of Operation
C2	Command and Control
CAF	Canadian Armed Forces
CAOC	Combined Air Operations Centre
CDAI	Canadian Defence Associations Institute
CDS	Chief of Defence Staff
CF	Canadian Forces
CFAWC	Canadian Forces Air Warfare Centre
CFDS	Canada First Defence Strategy
DAR	Director Air Readiness
DCA	Defensive Counter Air
DND	Department of National Defence
EDC	Enduring Defence Challenges
EEZ	Exclusive Economic Zone
FOL	Forward Operating Location
FRL	Flight Refueling Ltd.
FWSAR	Fixed Wing Search and Rescue
GoC	Government of Canada
HIFR	Helicopter in-flight refueling
HMCS	Her Majesty's Canadian Ship
ICBM	Intercontinental Ballistic Missiles
ISIL	Islamic State of Iraq and the Levant
ISR	Intelligence Surveillance and Reconnaissance
JP-3-17	U.S. Doctrine Joint Publication 3-17
MPA	Maritime Patrol Aircraft
MND	Minister of National Defence
MR	Mission Ready
NATO	North Atlantic Treaty Organization
NFPS	National Fighter Procurement Secretariat
NM	Nautical Miles
NORAD	North American Aerospace Defence Command
OCA	Offensive Counter Air
OEF	Operation Enduring Freedom
OGD	Other Government Departments
OIR	Operation Inherent Resolve
PBO	Parliamentary Budget Officer
RAF	Royal Air Force
RAAF	Royal Australian Air Force
RCAF	Royal Canadian Air Force
ROBE	Roll On Beyond-Line-of-Sight Enhancement

RW	Rotary Wing
SAR.....	Search and Rescue
SLBM.....	Sea Launched Ballistic Missiles
TBS	Treasury Board of Canada Secretariat
UAV	Unmanned Aerial Vehicle
UK.....	United Kingdom
UNCLOS.....	United Nations Convention on the Law of the Sea
US.	United States
USAF	United States Air Force
USMC.....	United States Marine Corps

ABSTRACT

The 2008 Canada First Defence Strategy emphasized the need for new fighter aircraft and a number of other large projects, but conspicuously absent from the acquisitions list was a replacement for a future air-to-air refueling (AAR) platform. Although the future fighter replacement project provided a forum for Canadians to have a meaningful debate over the future of AAR in the RCAF, the focus was instead on the incompatibility issue rather than the fact that the tankers were at the tail end of their service life. Air power theorists, as well as capstone and keystone doctrine, make a clear distinction on the AAR role as both a force multiplier and force enabler; providing the necessary arguments for the preservation of this key operational capability.

Invariably, the government will call upon the RCAF to respond to sovereignty concerns in the Arctic or an emerging international event necessitating immediate intervention. The unique enabling capability that AAR provides to RCAF operations is critical to modern air power capabilities. This study demonstrates the need to retain and expand the AAR role so as to provide the necessary rapid movement of aircraft, ensuring the preservation of national sovereignty/security while Canada retains its ability to independently project power internationally.

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INTRODUCTION

Victory smiles upon those who anticipate the changes in the character of war.

—Guilio Douhet

In 2012 the Treasury Board of Canada Secretariat (TBS), in response to a report from the Office of the Auditor General, hired the global auditing firm KPMG to conduct an independent review on the full life-cycle cost of the future fighter aircraft replacement program (based on the sole sourced purchase of the F35A). The Office of the Auditor General highlighted the fact that the Department of National Defence (DND) program office had underestimated the full life-cycle cost of the aircraft by limiting its estimates to 20 years.¹

KPMG released the independent review in November 2012. The document provided more fodder for the opposition and critics alike when the final estimated 42 year life-cycle cost came in at approximately 45 billion dollars (compared to the 20 year/16 billion dollar DND estimate²), further exasperating the procurement challenges associated with the future fighter. Within the same KPMG document, the opposition and critics also seized on a quote from DND stating: "with respect to air-to air-refueling (AAR) requirements, DND will rely on NORAD, coalition partners, or commercial refueling assets to meet operational requirements."³ Instead of engaging in a meaningful discussion of the strategic importance of aerial refueling in the context of Canadian sovereignty and

¹ Government of Canada, *Report of the Auditor General of Canada to the House of Commons Chapter 2: Replacing Canada's Fighter Jets* (Ottawa, spring 2012),16., Last modified [or accessed] 14 February 2015; http://www.oag-bvg.gc.ca/internet/docs/parl_oag_201204_02_e.pdf

² *Ibid.*, 3.

³ KPMG, *Next Generation Fighter Capability: Independent Review of Life Cycle Cost* (Ottawa, 27 Nov 2012): 21; <https://www.tbs-sct.gc.ca/reports-rapports/ngfc-cng/irlc-eiccv/irlc-eiccv-eng.pdf>; Internet; accessed 8 February 2015. NORAD: North American Aerospace Defence Command.

international operations, however, debate centred on the fact that the Royal Canadian Air Force's (RCAF) current AAR fleet was no longer compatible with the F35A. The CC-130T Hercules and the CC-150T Polaris have served Canada well in the AAR role, but both aircraft types are nearing the end of their useful life and need replacement within the same time frame as the CF-188 (currently estimated to be around 2025).⁴

Any modern air force would be hard pressed to argue against the versatility and flexibility that AAR provides in operations. However, meaningful study and evaluation of the impact of the RCAF losing its AAR capability has not taken place. This research paper will therefore advocate for the maintenance and expansion of this strategic capability by highlighting the inherent advantages of aerial refueling and the potential for additional missions above and beyond the current operational mindset. The need for Canada to emphasize the AAR role and plan for the future has never been more prevalent. Domestically, Canada has vast expanses of territory to cover and without the ability to refuel its own aircraft, the argument can be made that Canada cannot defend its own borders or protect its citizens. Internationally, the ability for Canada to deploy unilaterally without requesting support from its allies or "renting" AAR is just as important as being able to assert sovereignty: the RCAF must be capable of independent operations.

The Government of Canada (GoC) outlined those expectations in the 2008 Canada First Defence Strategy (CFDS). Specifically, it stated that the "Canadian Forces must be able 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

⁴ Department of National Defence, *CF-18 Hornet Estimated Life Expectancy*, last accessed [or modified] 30 April 2015, <http://www.forces.gc.ca/en/about-reports-pubs/next-gen-fighter-cf18-estimated-life-expectancy.page>

international security."⁵ The CFDS is the government's blueprint outlining the circumstances and operations in which it expects to employ the Canadian Armed Forces (CAF). If the RCAF is to deliver on those expectations, it must have the necessary equipment essential to the delivery of air power; and AAR is the critical enabler.

Russian activity in the Arctic will continue to pose a national security risk that requires the need for the persistent presence of fighter patrols throughout Canada's North. Without a dedicated tanker fleet, the RCAF will become solely reliant on the United States Air Force (USAF) to provide that role, thereby limiting Canada's own internal capability to defend its borders. The idea that Canada needs help to defend its borders goes against the concept of "defence against help," which dictates that a country has to establish and maintain military credibility if it is to avoid unwanted "help" from its larger neighbour.⁶ The loss of the AAR role would further marginalize the RCAF's operational capability to defend North America, creating a dependence on the United States (US), for Canadian national sovereignty and security.

⁵ Department of National Defence, *Canada First Defence Strategy* (Ottawa: Canada Communication Group, 2008), 3.

⁶ Norwegian academic Nils Ørvik explains this concept further:

One credible objective for small states would be, while not attempting military resistance against a large neighbour, to persuade him that they are strong enough to defend themselves against any of the large neighbour's potential enemies. This could help avoid the actual military presence of the great neighbour on one's territory for reasons of military 'help' and assistance.

Nils Ørvik, "Defence Against Help – A Strategy for Small States?," *Survival*, Volume 15, Number 5 (September-October 1973), 228; Nils Ørvik, "The Basic Issue in Canadian National Security: Defence Against Help/Defence to Help Others," *Canadian Defence Quarterly*, Volume 11, Number 1 (Summer 1981), 8-15. Also see: David Charters, "Defence Against Help: Canadian-American Cooperation in the War on Terrorism," (Conference Papers -- International Studies Association, 2004), 11. EBSCOhost (accessed April 10, 2015).

<http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=16050608&site=ehost-live>

Academic literature on the subject of AAR is somewhat limited as most written material on air power tends to fixate on kinetic aircraft, with tankers relegated to only a few paragraphs – if at all. Richard K. Smith, in *75 Years of Refueling History* provides the most complete historical review of AAR, tracing its roots and providing a complete evolution of the role. Although others have written about air power, it is Smith's singular focus on AAR that stands out as the authority on the subject.⁷ Bill Holder and Mike Wallace in *Range Unlimited: A History of Aerial Refueling*, provide a similar synopsis, though they dedicate less attention to the early development of AAR.⁸ The book provides a comprehensive look into foreign AAR history and a focus on the 21st century tanker. Rebecca Grant's *The Tanker Imperative* focuses more on modern AAR capabilities, and in the process provides the necessary arguments to justify the need for tankers. In particular, she highlights the many advantages AAR has provided to the USAF during modern air operations.⁹ The justification is the impetus necessary to validate an increasing preponderance of AAR assets within the USAF. Keith Hutcheson in *Air Mobility: The Evolution of Global Reach*, details the role of AAR in past air mobility operations, though only briefly and in the overall general context of air transport operations.¹⁰ Larry Milberry's *Sixty years: the RCAF and CF Air Command 1924-1984*¹¹ and his *Air Transport in Canada Volume 2*¹² contain a very small number of anecdotal

⁷ Richard K. Smith, *75 Years of Refueling History* (Washington: U.S. Government Printing Office, 1998): <http://www.afhso.af.mil/shared/media/document/AFD-100929-015.pdf>; Internet, accessed 17 Feb 2015

⁸ Bill Holder and Mike Wallace, *Range Unlimited; A History of Aerial Refueling*. (Atglen PA: Shiffer Publishing Ltd., 2000).

⁹ Rebecca Grant, *The Tanker Imperative*. Mitchell Institute for Air power Studies (Mitchell Institute Press, 2009).

¹⁰ Keith Hutcheson, *Air Mobility: The Evolution of Global Reach* (Beltsville MA: Todd Allan Printing, 1999).

¹¹ Larry Milberry, *Sixty Years: The RCAF and CF Air Command 1924-1984* (Toronto: Bryant Press Limited, 1984)

¹² Larry Milberry, *Air Transport in Canada*, (Toronto: CANAV Books, 1997).

AAR subjects; significantly, no recent academic writing on Canadian AAR exists. The RCAF capstone Aerospace Doctrine outlines the importance of the role within the air force and within the keystone Move Doctrine.¹³¹⁴ However both doctrine manuals the definitive essential AAR mission outline found in the USAF Joint Doctrine publication 3-17.¹⁵ Accordingly, a number of other government source documents as well as primary sources were used to amplify the need to retain the role for the RCAF.

In five chapters, this study will lay out the case for Canada to maintain and potentially expand the AAR role in the future. Chapter 1 will delve in the historical aspect of AAR from both an international and Canadian perspective. It will provide a summation of the development of AAR from its infancy through the ages, and add the context to which Canada first procured and modified two Boeing 707s forming the backbone of its air refueling fleet in the early 1970s. This historical approach will provide the foundation for the argument that the maintenance and expansion of this role within the RCAF is essential to Canada's ability to conduct meaningful operations independent of other nations' support.

Chapter 2 will emphasize the works of the early air power theorists Giulio Douhet, Hugh Trenchard, and Billy Mitchell; linking the development of their theories and influence on the modern use of air power to the importance of AAR. In the same context as the air power theorists, Carl von Clausewitz's work on the principles of warfare theory has had tremendous influence on the current Canadian Forces (CF) Aerospace Doctrine,

¹³ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine* (Ottawa: DND Canada, 2010)

¹⁴ Department of National Defence, B-GA-404-000/FP-001, *Canadian Forces Aerospace Move Doctrine* (Ottawa: DND Canada, 2011)

¹⁵ Department of Defense, *Joint Publications 3-17 Air Mobility*, 2013 (CD-ROM)

providing context from which the AAR role is integral to the RCAF. The fundamental link from the capstone document (CF Aerospace Doctrine) to the keystone document (CF Move and Shape Doctrine) will further correlate the warfare theories and today's operational doctrines to substantiate the increasingly critical role that AAR provides in enabling air operations.

Chapter 3 will focus on the role of AAR within the national sovereignty context placing the emphasis on the Arctic. Although the threat to Canada may seem remote, the consequences of inaction will undermine the ability for Canada to ascertain its position on the Arctic region. Through militarization, and the pursuit of oil riches from the thawing ice shelf due to climate change, the Arctic will play an integral part in international politics for the foreseeable future. Russia's President Vladimir Putin sees the Arctic as being within his country's sphere of influence, and has pledged to increase Russia's military presence in the Arctic; Canada's response to Russia's militarization has paled in comparison. This chapter shows that the potential demise of the tanker fleet would further limit the government's ability to project power within its northern borders and assert Canadian sovereignty. Canadians also expect the RCAF to respond rapidly to requests for help and the current AAR role focusing on fighter operations could expand to include other platforms such as helicopters. By improving the response time, AAR has the potential to revolutionize how the RCAF conducts search and rescue (SAR) and responds to major disasters.

Chapter 4 will focus the need for AAR during expeditionary operations. The focus will be to review previous operations and provide the necessary context to further justify the intrinsic role that AAR plays in modern air operations such as Kosovo, Libya,

Afghanistan and, more recently, Iraq. Casualty aversion has made air power the first political choice in the West when taking the decision to project power beyond national borders. With its own tanker fleet, Canada could contribute meaningfully to international operations and the RCAF would also maintain its own integral capability to deploy its fighters to the area of operation. AAR links directly to the RCAF's expeditionary capability, without which the RCAF becomes incapable to project power.

Chapter 5 will examine the RCAF of tomorrow and provide more background on future missions and the acquisition of aircraft that would be capable of being air refueled should the need arise. The time to have the conversation about the RCAF's future tanker is now, not in 10 years when the current fleet retires from service due to obsolescence. The chapter will review the evolution of the tanker re-capitalization programs from the USAF and other allies as an example to potentially emulate. The chapter will also provide recommendations for the RCAF to adopt as its future AAR capabilities evolve, and include a technical assessment that gives a holistic view of the potential RCAF AAR capable fleet.

The totality of the separate arguments outlined in the chapters will provide a clear rationale on the strategic importance of maintaining AAR as an RCAF capability, regardless of the eventual fighter replacement for the CF-188, and even expanding this vital role. To disregard the importance of providing the RCAF an integral AAR capability would further erode Canada's ability to project air power domestically and internationally, far outweighing the cost of investing in a new AAR fleet.

CHAPTER 1: THE HISTORY OF AAR

Historical examples clarify everything and also provide the best kind of proof in the empirical sense.

– Karl von Clausewitz, *On War*, 170.

When the Wright brothers first flew the *Flyer* on December 17 1903, their initial flight covered a total distance of 120 feet and lasted 12 seconds.¹⁶ It was this day that started an aviation revolution, for aiming to increase the airplane's range and speed became every aircraft designer's goal. The rapid advancements in aviation led to the first experiment with in-flight refueling a mere six months before the 20th anniversary of the Wright Brothers' historical flight. On June 25 1923, two US Army Air Service aircraft transferred 75 gallons of fuel using a simple hose (Figure 1.1).¹⁷ This was the beginning of air-to-air refueling and although the basic hose system utilized was very rudimentary, the airmen had shown that the concept of AAR was a viable solution to extending the range of aircraft.

¹⁶ Eye Witness to history, <http://www.eyewitnesstohistory.com/wright.htm>; Internet, accessed 17 Feb 2015.

¹⁷ Smith, *75 Years of Refueling History...*,1.

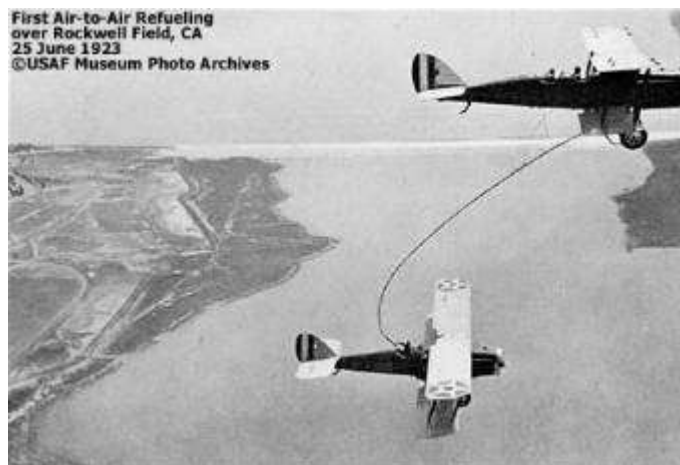


Figure 1.1¹⁸

This chapter will focus on the history of AAR, providing the necessary background to highlight the importance of this role. From the first attempt at AAR, to the need for long range bombing during the Cold War, this chapter will briefly examine the evolution of the AAR role to include the technical advancements leading to the designs found on today's tankers. Chapter 1 will also look at the development of AAR in the RCAF and provide the background as to how this role became more prominent in Canada.

AAR: Tanker and Receiver

Since the inception of AAR in 1923, the means have evolved with advancements in technology; nonetheless, the intent of refueling remains the same as the first mission. The definition AAR is simple: it is the act of transferring fuel in-flight between two aircraft; a tanker and a receiver.¹⁹ The tanker can be any aircraft that is capable of transferring fuel to another aircraft. The original tankers had very few modifications compared to today's purpose-built tanker aircraft. Most of today's tankers have additional

¹⁸ National Air Force Museum, "First Air to Air Refueling", last modified [or accessed], 11, April 2015, <http://www.nationalmuseum.af.mil/shared/media/photodb/web/050714-F-1234P-007.jpg>

¹⁹ This definition is based on the author's extensive experience in AAR.

fuel storage in order to maximize the ability to offload fuel to the receiver aircraft. The receiver is an aircraft capable of accepting fuel from the tanker usually done through modifications or designed at the onset by the manufacturer. Early methods of refueling were basic: using a hose and funnel to pass fuel from the tanker to the receiver.²⁰ As technology progressed, designers perfected two methods of refueling still in use today: the probe and drogue and the flying boom.

Probe and Drogue vs. Boom

The description of the two types of AAR methods is important to understand as both systems encompass advantages and disadvantages. Developed by Flight Refueling Limited (FRL), the probe and drogue design is the system used by a number of North Atlantic Treaty Organization (NATO) countries, including the RCAF, the US Navy and the US Marine Corps (USMC) (Figure 1.2). The system consists of a hose extending from the tanker, with a basket attached to the end containing a coupling device within. The basket (drogue) serves to stabilize the hose and provide a target for the receiver pilot with which to align the probe while approaching to make contact. The receiver aircraft is equipped with a probe which enables that aircraft to couple to the basket and receive fuel from the tanker. The boom method of refuelling (Figure 1.3) is a system originally designed to refuel less manoeuvrable aircraft (such as large aircraft). In this AAR method, the receiver aircraft simply flies in close proximity to the tanker and the boom operator in the tanker "flies" the boom and connects with the receiver aircraft. This system has become the preferred method of refueling by the USAF.²¹

²⁰ Smith, *75 Years of Refueling History...*, 1.

²¹ Smith, *75 Years of Refueling History...*, 43.

Figure 1.2, Probe and Drogue²²Figure 1.3 Boom²³

These two systems both have advantages and disadvantages, which make choosing one over the other a difficult task. The probe and drogue has the benefit of being a more flexible system, capable of refueling both fixed wing aircraft and helicopters (capable of slower speeds). In a RAND Corporation study, Paul Killingsworth also shows that this method provides more AAR capability (2 hoses vs.1 boom); thereby reducing the number of tankers required during major operations.²⁴ In contrast, the boom system's major advantage over the probe and drogue method is the higher rate at which it can refuel a receiver aircraft.²⁵ Understanding the idea of AAR provides the necessary background to delve into the evolution of the role as a critical enabler for air power.

²² Canadian Forces Imagery Gallery, "A CF-18 Hornet fighter jet refuels while conducting a mission over Iraq during Operation IMPACT on February 4, 2015" last modified [or accessed] 15 April 2015, http://www.combatcamera.forces.gc.ca/netpub/server.np?find&catalog=photos&template=detail_eng.np&field=itemid&op=matches&value=67333&site=combatcamera

²³ Air Mobility Command, "F-16 Being refueled by KC-135R" , last modified [or accessed], 15 April 2015, http://www.amc.af.mil/photos/media_search.asp?q=KC-135&page=3

²⁴ Paul Killingsworth, "Multipoint Aerial Refueling: A Review and Assessment," (RAND National Defense Research Institute, Contract DASW01-95-C-0059, 1996), 50.

²⁵ *Ibid.*, 20. As indicated in the study, the refueling rate is predicated on the receiver's capability to take the fuel. Prevailing estimates is that the boom system is 25-50 percent faster.

Proving a Concept

As a consequence of that first AAR flight in 1923 using two tanker aircraft²⁶ (the top aircraft in Figure 1.1) and fourteen fuel transfers, the receiver aircraft was able to stay airborne for thirty-seven hours and twenty minutes, which at that time was a world record for flight endurance. The aircraft covered a distance of 3,293 miles in a set orbit.²⁷ The first operational demonstration of the viability of the AAR concept was in the autumn of that same year. On October 25, 1923, an aircraft took off from Suma, Washington and tracked south where it joined up by the first tanker near Eugene, Oregon. It continued its flight south, where it met up with the second tanker over Sacramento, California. After 12 hours of flying and four refueling evolutions, the aircraft landed at Rockwell Field (today known as of Naval Air Station North Island) in San Diego. The total mission of 1280 miles clearly demonstrated the ability of AAR to extend the normal range of the receiver aircraft by more than four times (the receiver aircraft had a range of 275 miles without refueling).²⁸

In 1923, the British and French also attempted similar trials but, like the US, they did not move beyond the proof of concept flights. As Richard Smith noted, “Aerial refueling was a solution in search of a problem.”²⁹ However, following a world endurance record conducted by the Belgium Air Force in 1928, the US sought to re-visit developing the AAR concept. The direction from Major General James E. Fechet, Chief of the Air

²⁶ The "tanker" aircraft were no different than the receiver aircraft (all three aircraft were De Havilland DH4B); they were not modified to carry more fuel than the receiver. This was simply an attempt at proving a concept. In today's context, a tanker is an aircraft modified to carry additional fuel and capable of refueling a compatible receiver. Most tankers are modified commercial aircraft such as the modern A330 or Boeing 767.

²⁷ Smith, *75 Years of Refueling History...*, 1.

²⁸ *Ibid.*, 1.

²⁹ *Ibid.*, 2.

Corps, was that the proof of concept needed to lead to an actual operational military role.³⁰ After modifying a Fokker C-2A tri-motor high wing aircraft as the receiver aircraft and two Douglas C-1 single-engine transports biplanes as the tankers (installing two 150-gallon tanks for offloading and a refueling hose that passed through a hatch cut in the floor), Operation Question Mark was underway (Figure 1.4).³¹ On January 1, 1929, the aircraft piloted by Major Carl Spaatz (later becoming the first Chief of the Air Staff in 1941),³² took off from the Metropolitan Airport in Van Nuys. Two tankers supported him during this world endurance record breaking attempt. The plan was to set-up a racetrack orbit between two airfields: Metropolitan and Rockwell Field. After 150 hours of continuous flying, 34,000 lbs of fuel and only one engine remaining, the Question Mark had to land due to serviceability – not for lack of fuel – proving the immense potential of AAR as an operational capability.³³ Other AAR attempts would soon be made.

³⁰ Ibid., 3.

³¹ As Smith explains, "The Fokker was painted with a large question mark intended to provoke wonder at how long the airplane could remain airborne." Ibid.

³² Historynet, *Carl A. Spaatz: An Air Power Strategist*, last modified [or accessed] 21 Feb 2015, <http://www.historynet.com/carl-a-spaatz-an-air-power-strategist.htm>

³³ Smith, *75 Years of Refueling History...*, 11. Five months after the flight of the Question Mark, the US Army Air Corps conducted a more formal operational demonstration of AAR. Unfortunately the weather did not cooperate and the mission failed. The "answer" to the Question Mark did not impress the US War department and AAR was shelved for the next 12 years.

Figure 1.4³⁴

In 1935 after 653 hours, 484 mid-air refueling missions and 6000 gallons of fuel, brothers Al and Fred Keys flying the Curtiss Robin receiver aircraft "Ole Miss" and refuelled by another Curtiss Robin set the all-time endurance record.³⁵ Remarkably, the aim of this record breaking feat was to showcase their town of Meridian, Mississippi and help save the airport from closing. The AAR system they designed with the help of their friend A.D. Hunter, was based on an air hose used to fill tires, albeit more robust. The hose was fitted with couplings to prevent fuel spills, which was a first in the concept of AAR.³⁶ Their design became the precursor to the probe and drogue system widely in use today.

In 1929, Boeing became the first commercial company to test the viability of the AAR concept when its Model 40B became the company's first tanker aircraft. Although its intent was more to showcase the reliability of its new engine installed on the receiver aircraft, Boeing demonstrated the potential to cross the USA non-stop using AAR by

³⁴ "Operation Question Mark, " last modified [or accessed] 21 February 2015, <http://silodrome.com/operation-question-mark/>

³⁵ Smith, *75 Years of Refueling History...*, 9.

³⁶ Historic Wings, *The Flying Brothers*, last modified [or accessed] 21 February 2015, <http://fly.historicwings.com/2013/06/the-flying-keys/>

accomplishing the feat in just over 28 hours.³⁷ In 1948, Boeing became a leader in AAR, designing the Boeing flying boom refuelling system, still in use today.³⁸

Across the Atlantic, the British were becoming the leaders in developing a viable AAR concept. Sir Alan Cobham is a name synonymous with AAR, even to this day. Closely following the technical developments, Cobham found most of them to be crude and simple and, in his estimate, most AAR systems conceived had a number of safety and technical challenges. In the early 1930s, Cobham conducted several trials on a number of systems, eventually overcoming the early design flaws and producing an operationally effective method of AAR. On October 29 1934, he formed Flight Refueling Ltd. (FRL) and awarded his first AAR experimental contract for the Royal Air Force (RAF) in August 1937.³⁹ However, upon the outbreak of the Second World War, the RAF's preoccupation with other air power roles led to the abandonment of the trials by FRL with one exception: Project "Tiger Force." As part of the plan to deploy Lancaster bombers to take part in the potential invasion of Japan, FRL was to modify 600 Lancaster bombers into tankers by 1945. The contract was later cancelled when the US seized an airfield in close proximity to Japan, rendering the need for tankers moot.⁴⁰

The Cold War

It was not until 1947 that AAR was once again an important concern of American airmen. Indeed, it was the newly-formed United States Air Force (USAF) that would take lead (arguably one it has never relinquished) in the conceptual and technological

³⁷ Smith, *75 Years of Refueling History...*, 8.

³⁸ *Ibid.*, 27.

³⁹ Bill Holder and Mike Wallace, *Range Unlimited...*, 21.

⁴⁰ *Ibid.*, 22.

development of AAR. Practicality was a primary driver: the new realities of the Cold War had begun to emerge and the USAF did not have a bomber capable of conducting return bombing trips against the Soviet Union from the continental United States. The B-36 was big enough to lug the large nuclear weapons of the time and carried enough fuel to make the round-trip flight. However, as the B-36 originally designed for the European theatre, it lacked speed and manoeuvrability and thus became highly vulnerable to enemy jet fighters.⁴¹

Aircraft designers informed the USAF leadership that they were at least seven years away from being able to field a bomber with the speed and manoeuvrability required to strike the Soviets.⁴² As Bill Holder and Mike Wallace note, "Boeing was still designing the jet-propelled B-47 and B-52... However, these new aircraft -- unlike the B-36 -- needed air refueling to hit targets in the Soviet Union."⁴³ At the time of the development, no aerial refueling aircraft existed. Therefore, the only solution was to press forward and develop a viable AAR system in order to extend the range of its bomber fleet.

⁴¹ Air Mobility Command, "U.S. military aerial refueling: extending 'the reach,'" last modified [or accessed], 11 April 2015, <http://www.amc.af.mil/news/story.asp?id=123138375>

⁴² Bill Holder and Mike Wallace, *Range Unlimited...*, 22.

⁴³ Air Mobility Command, "U.S. military aerial refueling: extending 'the reach,'" last modified [or accessed], 11 April 2015, <http://www.amc.af.mil/news/story.asp?id=123138375>

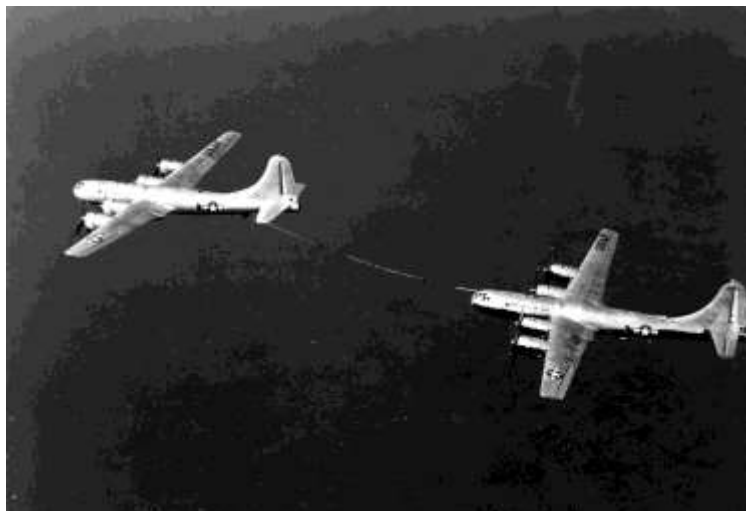


Figure 1.5⁴⁴

Having followed closely the advancements that FRL had made in the development of AAR, the USAF contracted FRL and Boeing to modify B-29s. Over the next two years, the KB-29 (Figure 1.5) was successfully tested on a number of different fighters and bombers using the FRL designed "looped hose refueling" method.⁴⁵ In 1949, The KB-29 became the first operational tanker in the USAF inventory. It flew its first combat mission during the Korean War, when it refueled two F-84s outfitted with probes. Later in 1949 air refueling once again demonstrated its ability to provide receiver aircraft with extended range capability when a B-50 bomber, nicknamed "Lucky Lady," flew the first nonstop flight around the world in 94 hours.⁴⁶

⁴⁴ Deutche Academic, "KB-29M tanker" last modified [or accessed] 11 April 2015,

<http://de.academic.ru/pictures/dewiki/107/kb29srefueling.jpg>; picture of a KB-29M refueling a B-29.

⁴⁵ Bill Holder and Mike Wallace, *Range Unlimited...*, 13-14. In order to support fighter AAR operations, the looped hose system was modified in 1949 and became known as the probe and drogue system.

⁴⁶ *Ibid.*, 15. The B-50 was a re-engined B-29, giving the aircraft improved speed and range. Most of these aircraft would later be modified as KB-50 tankers.



Figure 1.6⁴⁷

In early 1950 the first boom equipped tanker, the KB-29P (Figure 1.6), made its appearance. Although the utilization of the probe and drogue method would continue, the new Boeing-designed boom refueling system was quickly becoming the USAF standard. As a USAF Air Mobility Command study put it, "The new design allowed more positive control of the air-to-air refueling operation and, with the boom's four-inch diameter; it offered much faster fuel transfer."⁴⁸ In early 1951 the USAF took delivery of the AAR boom system-equipped KC-97, a propeller driven Boeing built variant of the C-97 Stratofreighter (Figure 1.7). Replacing the KB-29, the KC-97 became the backbone of the USAF AAR fleet during the early Cold War period. In total, the USAF purchased 816 KC-97s between 1951 and 1956.⁴⁹

⁴⁷ Air Mobility Command, "Photo of KB-29P," last modified [or accessed], 11 April 2015, <http://www.amc.af.mil/news/story.asp?id=123138375>

⁴⁸ Air Mobility Command, "U.S. military aerial refueling: extending 'the reach,'" last modified [or accessed], 11 April 2015, <http://www.amc.af.mil/news/story.asp?id=123138375>

⁴⁹ National Museum of The US Air Force, Boeing KC-97L Stratofreighter, last modified [or accessed] 11 April 2015, <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=374>

Figure 1.7⁵⁰

Although the KC-97 proved to be a very competent tanker aircraft, its slower speeds and inability to reach similar altitudes of the frontline bombers and fighters proved detrimental to operations. This issue forced the USAF to modify some of their B-47s (jet engine powered vice the propeller driven KC-97) for the AAR role. This developmental aircraft had the higher speed and altitude required; however, the limited numbers of B-47s and realizing the high cost of the KB-47, the USAF cancelled the program in favour of developing a true jet powered tanker aircraft.⁵¹ In 1954, following a demonstration by Boeing, the USAF ordered the first jet powered designed tanker: the KC-135 Stratotanker. Between 1957 and 1965 Boeing delivered 820 KC-135s equipped with Boeing's AAR boom refueling system, thus ending the USAF use of the probe and drogue. After more than 50 years of service, the KC-135 (Figure 1.8) still forms the

⁵⁰National Museum of The US Air Force, Boeing KC-97L Stratofreighter, last modified [or accessed] 11 April 2015, <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=374>

⁵¹ Bill Holder and Mike Wallace, *Range Unlimited...*, 18.

backbone of the USAF's AAR fleet.⁵² This incredible feat of longevity is a testament to the aircraft and its importance to the USAF's capability to project air power.



Figure 1.8 KC-135⁵³

Lack of Air Power Projection

Unlike the USAF, the RCAF did not initially focus on acquiring an AAR tanker because it lacked the ability to project air power. From the onset of jet-powered fighters, RCAF fighter aircraft were incapable of inflight refueling. Whereas the USAF began to exploit the advantages of AAR with its fighter during the Korean War,⁵⁴ as of 1952, the

⁵² Boeing History, KC-135 Stratotanker, <http://www.boeing.com/boeing/history/boeing/kc135.page>; Internet, accessed 21 February 2015.

⁵³ US Air Force Photos " KC-135" <http://media.dma.mil/2003/Mar/28/2000031166/-1/-1/0/030328-F-JZ000-050.JPG>

⁵⁴ Smith, *75 Years of Refueling History...*, 34. The USAF fighters were flying missions from Japan and the range required to hit targets in North Korea necessitated the use of AAR. Within 1 year, F-80s and F84s were modified and carrying out strike missions into North Korea.

USAF was moving its fighters from US mainland to Japan using AAR.⁵⁵ In contrast, in the early 1950s Canada began to stand-up its fighter presence in Europe, and the lack of AAR forced the RCAF to send its fighters onboard the aircraft carrier His Majesty's Canadian Ship (HMCS) *Magnificent* or fly them to Europe using the North Atlantic ferry route first designed in the Second World War.⁵⁶ The first of these operations took place under the name Operation Leap Frog, flying the newly built Canadair F-86 Sabres to Europe via Newfoundland, Greenland, Iceland, Scotland and England.⁵⁷

Operations of this nature were frequent through the 1950s and 1960s flying a number of RCAF jets from Canada to Europe (F-86, CF-100 and the T-33).⁵⁸ Had Canada chosen to procure the KC-135 or another tanker, and outfit its jets with AAR probes, those operations would have taken hours vice days (Operation Leap Frog 1 took 15 days).⁵⁹ Even the famed CF105 Avro Arrow, originally designed to be the RCAF's advanced interceptor in the 1950s and cancelled in 1959, had no inflight refueling capability, limiting its range to only 600 nautical miles (NM).⁶⁰ To put this range into perspective, the great circle distance from Cold Lake to Inuvik is approximately 1000 NM. The Arrow would have needed to stop to refuel or deploy further north to intercept the Soviet bombers of the day. This was the actual plan the RCAF was relying on: using a

⁵⁵ Ibid., 36. Operation FOX PETER ONE was the first of many Pacific deployments of fighters.

⁵⁶ Carl A. Christie, "Our First NATO Wing: No. 1 Fighter Wing, RCAF Station North Luffenham, Rutland, England, 1951-1955," (Historical Conference Paper, 2004), 23.

⁵⁷ Ibid.; National Defence, "Op Leap Frog," last modified [or accessed] 11 April 2015, <http://www.cmp-cpm.forces.gc.ca/dhh-dhp/od-bdo/di-ri-eng.asp?IntlOpId=180&CdnOpId=220>

⁵⁸ National Defence, "Op Leap Frog," last modified [or accessed] 11 April 2015, <http://www.cmp-cpm.forces.gc.ca/dhh-dhp/od-bdo/di-ri-eng.asp?IntlOpId=180&CdnOpId=220>

⁵⁹ North Luffenham "Canada to England 1952," Last modified [or accessed] 11 April 2015, <http://67.69.104.76:84/marville/other/maother-67d.html>, 20 F-86s from 439 Sqn departed Uplands on 30 May and arrived in North Luffenham on June 15.

⁶⁰ Richard Organ, et al., *Avro Arrow* (Erin, ON: The Boston Mills Press, 1980), 13.

number of forward operating locations (FOL) which included Whitehorse, Yellowknife, Fort Nelson and others in the eastern part of the country.⁶¹ Even with all these planned northern bases and the cost associated with their infrastructure needs, the Arrow would have had a very limited time to acquire and potentially engage the incoming Soviet threat (average distance of the proposed locations to Inuvik is approximately 600 miles). All of this planning and development was being done at the same time that the USAF was acquiring the KC-135. No evidence has yet come to light indicating that the RCAF at any point during the early Cold War desired to purchase the KC-135 or any other tanker.

The CF-5 Purchase: an AAR requirement for the RCAF

The 1968 Canadian government's decision to procure the CF-5 Freedom Fighter led Canada's air force leadership to seriously consider AAR capabilities for the RCAF. The acquisition of this platform with no apparent role was fraught with political intervention. What precipitated the purchase of this light weight close air support fighter was the penchant by then Minister of National Defence (MND) Paul Hellyer to rid the RCAF of the nuclear strike role in Europe. His bias led to the eventual purchase of the Northrop-built CF-5, an aircraft that the RCAF leadership flatly rejected as being unsuitable.⁶²

In 1970, tasked to support NATO's northern flank, the CAF deployed the CF-5 to Norway. The problem with this new role is that it took days to get the CF-5 to Norway,

⁶¹ Ibid., 134.

⁶² R. Stouffer, Major, "Cold War Air Power Choices for the RCAF: Paul Hellyer and the selection of the CF-5 Freedom Fighter," *Canadian Military Journal*, Autumn 2006, 63-64. When the RCAF took delivery of the first Canadian built CF-5 in February 1968, it had no operational role. As Stouffer noted, "Not only was the CF-5 unsuitable for the tactical environment of central Europe, it was incapable of meeting the even lower combat requirements of a UN mission." Ibid., 68.

requiring fuel stops in Goose Bay, Greenland, Iceland and the UK.⁶³ This was not exactly the rapid response that NATO was looking for on its northern flank. Although the CF-5 purchase was an incredible lack of foresight and acquisition mismanagement on the part of the Canadian government, the delays experienced in its deployment to Norway opened the door for the RCAF to secure an AAR capability.

In order to sustain the CF-5 fleet and fulfill its NATO commitment to Norway, the RCAF needed to purchase a tanker. The options at the time were limited: the KC-135 was no longer in production and the only two aircraft capable of the AAR role were the C-141 Starlifter and the Boeing 707. Purchasing the C-141 would require the Canadian government to make a quick decision because the aircraft's production was coming to an end. Unable to decide in time, the government only had one choice: the Boeing 707. In 1968, Boeing informed Canada of the availability of four 707-347Cs due to the cancellation of a purchase by Western Airlines. Delivery of the CC-137 (the Canadian Forces nomenclature for the Boeing 707) took place in April 1970 and the first tanker became operational two years later in May 1972.⁶⁴ The decision to modify the CC-137 for AAR was borne from a tactical necessity rather than strategic guidance.⁶⁵ However, the decision highlighted the essential role that AAR would play in future operations.

Operation Long Leap 1 on 9 June 1973 was the first mission to demonstrate the Air Force's new AAR capability. The operation took eight CF-5s from Canada to Andoya Norway in just six hours;⁶⁶ a far cry from the early deployments lasting days. This new capability allowed Canada to fulfill its new role within NATO and defend the northern

⁶³ Ibid., 73.

⁶⁴ Anthony L. Stachiw and Andrew Tattersall, *Boeing CC137 (707-347C)*, (St Catharines, ON: Vanwell Publishing Ltd., 2004), 19-20.

⁶⁵ Both the 1964 and the 1970 White Paper on Defence make no mention of a need for AAR. The author was unable to find evidence of any other policy regarding the AAR role during that time period.

⁶⁶ Anthony L. Stachiw and Andrew Tattersall, *Boeing CC137...*, 20.

flank. The AAR role also gave Canada the ability to project power in the Arctic by conducting northern sovereignty patrols using fighter aircraft supported by a tanker. On 18 June 1979, Operation Ice Cap demonstrated this very capability when one CC-137 and four CF-5s flew to the North Pole, orbited and returned south.⁶⁷ The main interceptor, the CF-101B Voodoo, was unable to complete the mission due to its lack of an AAR capability.⁶⁸ The year 1984 saw the arrival of the new AAR capable CF-188 Hornet, and with the support of the CC-137, it was flying non-stop from Canada to Germany. The 1991 deployment of CF188s' to Desert Storm, from Germany directly to Doha, Qatar, exemplifies the enabling characteristic to project power independent of allies.⁶⁹ The CC-137 tanker became a mainstay in the RCAF and proved the merits of AAR and the advantages to having tankers at the ready for power projection and rapid deployment capability.⁷⁰

Conclusion

The relentless pursuit that the pioneers of AAR displayed in the development of a technically challenging role was, beyond a doubt, one of the most significant achievements in military aviation. The provision of AAR negates the range and persistence challenges affecting air power. No longer are a strike aircraft and/or bomber limited to their own design limitations to reach targets.

⁶⁷ Ibid., 20.

⁶⁸ "Air Vectors, "The McDonnell Douglas F-101," last modified [or accessed] 11 April 2015, <http://www.airvectors.net/avf101.html>

⁶⁹ Anthony L. Stachiw and Andrew Tattersall, *Boeing CC137 (707-347C)*, 21.

⁷⁰ Larry Milberry *Sixty Years: The RCAF and CF Air Command...*, 425,428. 1982 is an example of a typical year at 437; flying AAR in support of NATO Ex Allow Express, taking the CF-5 to Norway. It also participated in Ex. Red Flag and Ex. Maple Flag.

Establishing the historical significance of AAR is important to understanding the implications were the RCAF to abandon this role. The RCAF is at a crossroads, and there needs to be an effort taken over the next few years to defend the critical nature of the AAR role. As this chapter illustrates, the significance of AAR on history cannot be underestimated or overlooked and without focusing on this core role, the RCAF risks losing its only ability to independently project air power rapidly and efficiently in the future. The next chapter will tie the historical aspect of AAR with the theoretical and doctrinal employment of AAR in air warfare.

CHAPTER 2: Air Power Theories and Doctrine: a Case for AAR

Airpower may not arrive with the largest punch... but as a general rule airpower will be able to get there first.

– Colin S Gray

A discussion of air power theory, national strategy and air doctrine, is essential in order to provide the optimum clarity on the need to retain the core AAR role in the RCAF. Since air power theory only began shortly after the Wright Brothers' *Flyer* first took to the sky, air power theorists are in short number when compared to older military services. Many of the early air power theorists had limited breadth of scope (Giulio Douhet was an artillery officer and Billy Mitchell was an officer in the a Signal Corps), or simply did not take the time to truly articulate their thoughts beyond doctrinal manuals and memos, as was the case for Hugh Trenchard (widely known as the father of the RAF).⁷¹

Nevertheless, Douhet, Trenchard and Mitchell have made their mark on air power theory, and this chapter will reflect where the role of AAR conforms to their views and encapsulates their concepts. In order to put the work of these air-minded individuals into perspective, the theories of famed military theorist Carl Von Clausewitz will also be examined. It is important to review his work because his *Principles of War* have influenced the CF Aerospace Doctrine, and in fact provide the foundation for the document. The examination of air power theory will be the basis for the assessment of Canadian national strategy and RCAF strategic and operational doctrine.

Theorists

⁷¹ Phillip S. Meilinger, *Airwar: Theory and Practice* (Portland OR: FRANK CASS, 2003), 36.

The search for a greater sense of the AAR role and its place within the RCAF must begin with reviewing the works of Clausewitz. He is one of the most influential war theorists, and his writings are standard to which many strategists and air power theorists (including Douhet and Trenchard) turn to in order to validate concepts of war.⁷²

Clausewitz's most famous work *On War* provides the basis for strategic theory which he describes as "an attempt to shed light on the components of war and their interrelationships, stressing those few principles or rules that can be demonstrated."⁷³

Clausewitz's main premise on strategic theory is the principles of warfare. Air theorists find these principles relevant to their studies of air power⁷⁴ and the CF Aerospace Doctrine uses these same principles as its foundation.⁷⁵ Another key component of Clausewitz's work is his definition of the enemy centre of gravity, which he states "is always found where the mass is concentrated most densely. It presents the most effective target for a blow; furthermore, the heaviest blow is that struck by the centre of gravity."⁷⁶ The definition was central to early air power theorists focusing on the aircraft's ability to target the enemy's centre of gravity without hindrance from terrain. Italian Giulio Douhet was one of the first to advocate this concept using air power.

⁷² Born in 1781, and by the age of twelve in 1793, Clausewitz saw his first action as a lance corporal. In 1801 he attended the new War College in Berlin and graduated in 1803 at the top of his class. Writing his first essay on the theory of warfare was in 1804, he made the connection with war as an extension of politics. His most famous work *On War* was published by his widow a year after his death in 1832. Carl Von Clausewitz, *On War ...*, 5, 8-9, 27.

⁷³ *Ibid.*, 177.

⁷⁴ Scot Robertson, "The development of Royal Air Force strategic bombing" *Airpower Journal* 12, no. 1, (Spring 1998), 37. Robertson describes the inter-war RAF air power theory development: "analysts flouted the Clausewitzian dictum regarding the search for first principles through rigorous historical examination and critical analysis to determine cause and effect."

⁷⁵ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine...*, 23.

⁷⁶ Carl Von Clausewitz, *On War...*, 485.

One of the more celebrated air power theorists, Douhet was an astute writer, arguing the merits of the airplane not as a defensive weapon but as an offensive arm when compared to the army and navy.⁷⁷ He defends his point by highlighting the fact that an aircraft is not impeded by terrain or massing armies; instead the aircraft can take off and attack in any direction from its base within the radius of action, exploiting the advantages of the third dimension.⁷⁸ When describing Douhet's concept on radius of action, Colin S. Gray in *Explorations in Strategy* writes, "the nature of the air environment... literally has the range to reach anywhere on the globe. From its home base in Whiteman Air Force Base, the B-2 bomber can reach anywhere on earth within 23 hours and deliver its smart ordnance."⁷⁹ The example cited by Gray using AAR outlines the modern concept inferred by Douhet's work on the aircraft as an offensive weapon and highlights the critical role AAR plays in enabling that unlimited reach capability.

Douhet further elaborated his concept on radius of action by describing the relationship between range and ordinance capacities on aircraft. He remarked "the elasticity in the radius of action can be secured by a few extra details of construction to allow for adjustment of the total load between fuel weight and bomb weight."⁸⁰ In today's context, a fighter, bomber or transport aircraft can increase their loads, be it munitions or cargo, and minimize fuel knowing the ability to reach their intended target will not be impeded because of the availability of AAR. Douhet professes the need to appropriately

⁷⁷ Douhet was born in 1869 in the small town of Caserta; he later attended the Genoa Military Academy and was commissioned as an artillery officer in 1888.⁷⁷ He was extremely interested in anything mechanical and even more so in technological advancements, it came as no surprise that, after Italy flew its first aircraft in 1908, and he began to think "seriously about the impact of aircraft" on military operations. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (New York: Coward McCann, 1942), vii.

⁷⁸ *Ibid.*, 16.

⁷⁹ Colin S. Gray, *Exploration in Strategy* (Westport CT: Praeger Publishing, 1998), 68.

⁸⁰ Giulio Douhet, *The Command of the Air*..., 39.

equip the air force for potential future conflicts: "in order to assure an adequate national defence, it is necessary and sufficient to be in a position in case of war to conquer the command of the air."⁸¹ Douhet paints a clear picture on the need to be preparing for the next war and the RCAF must therefore stay relevant and capable of command of the air in the next conflict, as Clausewitz pointed to his book *On War*, "war is simply a continuation of political intercourse, with the addition of other means."⁸² Put in classic air power terms, AAR is a force multiplier,⁸³ providing the RCAF with the advantage of reach, and speed⁸⁴, allowing strike aircraft to control the air through the conduct of offensive counter air (OCA) missions.⁸⁵ Douhet's emphasis on defence preparedness ties in the need to maintain AAR within the RCAF because without it, command of the air becomes impossible due to the vastness of Canada. From Douhet's perspective on air power theory, the logical follow-on is the work of Sir Hugh Trenchard.

Marshal of the RAF Sir Hugh Trenchard⁸⁶ was Britain's first Chief of the Air Staff from 1919 until 1930.⁸⁷ Unlike Douhet, Trenchard was not a prolific writer, and most of

⁸¹ Ibid., 28. "To have command of the air means to be in a position to prevent the enemy from flying while retaining the ability to fly one-self." Ibid., 24.

⁸³ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine*, 66. The concept "force multiplier" is defined as: A capability provided to a combat force that enhances the probability of success in mission accomplishment.

⁸⁴ Ibid., 25-26. The air power characteristic of Reach entails the projection of air power globally. The characteristic of Speed entails providing a rapid response projected over great distances.

⁸⁵ Department of National Defence, B-GA-403-000/FP-001, *Canadian Forces Aerospace SHAPE Doctrine* (Ottawa: DND Canada, 2014), 25. Offensive Counter-Air (OCA) supports the control of the air objectives by preventing the launch or employment of adversarial aerospace capabilities.

⁸⁶ Hugh Trenchard was born on February 3rd 1873 in Taunton, Somerset. Trenchard became a second lieutenant in the Royal Scots Fusiliers. His first posting was to India in 1893. He began his flying career in July 1912, he was not a particularly gifted flyer and he spent more time on administrative work and training procedures. In September 1912, Trenchard started to develop his ideas as to how aeroplanes could support men and weapons on the ground. When war was declared in August 1914 Trenchard was officially Officer Commanding the Military Wing of the Royal Flying Corps. Last modified [or accessed] 25 April, 2015, http://www.historylearningsite.co.uk/hugh_trenchard.htm

⁸⁷ Phillip S. Meilinger, *The Path of Heaven: The Evolution of Air Power Theory* (Maxwell AFB: Air University Press, 1999), 41.

the works linked to him are in the form of memos written between the two world wars and by his staffers who "translated" his thoughts into doctrine. Like Douhet, Trenchard professed the use of aircraft as an offensive weapon. Using the analogy of a soccer match he said "you may not lose if spend all your efforts defending your own goal, but you will certainly not win."⁸⁸ He too believed that striking deep into enemy territory was the best method of attaining victory from the air.

Again, similar to Douhet, Trenchard was also convinced that the aircraft's single greatest advantage was to strike at the "morale of the factory workers by targeting enemy factories and, by extension, the population as a whole."⁸⁹ Where they differed in some ways was their implied centre of gravity: where Douhet declared his desire to hit population centres to break their morale, Trenchard's focus was on the "vital centres" which included "organized systems of production, supply communications and transportation."⁹⁰ The use of AAR gives strike aircraft unlimited range and the advantages of reach and speed to strike deep into enemy territory and attack the centre of gravity Trenchard identifies. Turning from Trenchard's theories, Mitchell offers air power theories that resemble in some ways Trenchard and Douhet's work.

Just like Douhet and Trenchard, American Billy Mitchell was adamant that the air force be independent of the other services and that " bombers could win wars...quicker and cheaper than one obtained by surface forces."⁹¹ Like Douhet, Mitchell advocated "victory

⁸⁸ Phillip S. Meilinger, *Airwar: Theory and Practice...*, 46.

⁸⁹ Phillip S. Meilinger, *The Path of Heaven...*, 41.

⁹⁰ Phillip S. Meilinger, *Airwar: Theory and Practice...*, 49.

⁹¹ Phillip S. Meilinger, *The Path of Heaven...*, 79. Mitchell was born in 1879 in Nice France. His father was a US Senator and through those connections Mitchell received his commission to the signal corps at the age of 18. Posted to Alaska in 1901, he began to study aviation. Like Douhet, Mitchell developed an increasing curiosity about aviation, and in the fall of 1916 he paid for his own flying training. The result of

through airpower was to win control of the sky,"⁹² but unlike Douhet, Mitchell could see the advantages of defensive counter air (DCA).⁹³ Douhet viewed the aircraft as a purely offensive weapon, whereas Mitchell countered that control of the air was a combination of defence and offence. He believed in using aircraft to repel attacking enemy aircraft (DCA) and like Douhet and Trenchard, using bombers to strike at the enemy's vital points (OCA).⁹⁴ CF Shape Doctrine describes DCA as a "high-risk no-fail mission which must be resourced appropriately and executed effectively."⁹⁵ Defending Canadian airspace from adversaries is congruent with the concepts of defence (DCA) highlighted by both Mitchell and the current CF Shape Doctrine. Effective support to this no-fail endeavour over Canada's large territory rests with the enabling function that AAR provides. The need to articulate this essential role must reside within the doctrinal manuals of the RCAF.

Aerospace Doctrine

The link between strategy and doctrine is important to highlight to better understand the contextual difference. A strategy should encapsulate the government's national objectives and provide direction to the military for the conduct of operations. Doctrine focuses on how the military will wage war and what roles it deems essential to

his new skill set made him an "aviation expert" according to the US War Department (where he was working at the time), sending him to Europe as an observer. 79-83

⁹² Ibid., 98.

⁹³ Department of National Defence, B-GA-403-000/FP-001, *Canadian Forces Aerospace SHAPE Doctrine* (Ottawa: DND Canada, 2014), 33. DCA operations protect friendly forces, equipment, personnel, infrastructure, and vital interest from an adversary's aerospace power.

⁹⁴ Phillip S. Meilinger, *The Path of Heaven: The Evolution of Air Power Theory...*, 98.

⁹⁵ Department of National Defence, B-GA-403-000/FP-001, *Canadian Forces Aerospace SHAPE Doctrine...*, 33.

that effort without taking into account economic or political restraints.⁹⁶ The importance of doctrine to the air force can be "ensuring unity of purpose is achieved. It does this by formally establishing a set of principles that provide guidance for operations."⁹⁷ Those sets of principles guiding operations change with time, as the evolution of doctrine within the RCAF demonstrates.

Conceived in 1924, the first RCAF doctrine focused on the civilian application of air power focusing mainly on three functions "mapping, forestry, and communications."⁹⁸ The lack of focus on an actual air power doctrine continued well into the Second World War where the RCAF simply utilized RAF doctrine as its own to ensure its ability to operate with the RAF.⁹⁹ The Cold War pushed the RCAF to focus on achieving interoperability with the USAF and emulating their doctrine in large part due to the creation of the North American Air Defence Command (NORAD) in 1957.¹⁰⁰ In 1968, unification saw the RCAF disbanded, with all Canadian military air assets incorporated into a unified command structure, thereby eliminating "the processes and institutions for the development and promulgation of RCAF Doctrine."¹⁰¹ The Air Force council and the RCAF Staff College (rebranded as the CF Staff College) were disbanded, bringing to an end the development of the air doctrine. Allan English and Colonel John Westrop describe the 1970 air doctrine as "the views of separate air warfare communities cobbled

⁹⁶ Phillip S. Meilinger, *Airwar: Theory and Practice...*, 37-38.

⁹⁷ Aaron P. Jackson, "The Emergence of a Doctrinal Culture within the Canadian Air Force" *The Canadian Air Force Journal* Vol 2. No.3 (Summer 2009), 40.

⁹⁸ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine* (Ottawa: DND Canada, 2010), 8.

⁹⁹ Aaron P. Jackson, "The Emergence of a Doctrinal ...," 43.

¹⁰⁰ *Ibid.*

¹⁰¹ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine...*, 13.

together into one volume with little coherence or consistency."¹⁰² In 1997, the doctrine *Out of the Sun* replaced the 1989 *Basic Aerospace Doctrine*, with the intent on providing a new direction in Air Force doctrine.¹⁰³ The long span of time that the air force failed to publish a viable doctrine manual had a very real and negative effect on procurement for the RCAF.¹⁰⁴

As described earlier, doctrine provides the means to which the RCAF can articulate its needs in order to meet the government's direction. The year 2005 saw the creation of the Canadian Forces Aerospace Warfare Centre (CFAWC) in Trenton ON, an institution dedicated to the development of RCAF doctrine. Since its inception, the RCAF has made great strides in re-capturing what it had lost in 1968: an ability to build the RCAF foundation for the future through the publication of relevant doctrine. The need to describe the history of the RCAF doctrine is to highlight the fact that until CFAWC stood up in 2005; the development of RCAF doctrine had stagnated since unification.¹⁰⁵ This went against Colin Gray's learned advice that "doctrine needs constantly to be revisited as theory interacts with practice. Every Air Force has learnt some faulty lessons from a historical experience and has neglected to note lessons of enduring merit."¹⁰⁶ It is imperative that the RCAF maintain its new course, for falling back into a period of ad-hoc

¹⁰² Allan English and Colonel John Westrop, *Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operation*, (Trenton: Canadian Forces Aerospace Warfare Centre, 2007), 49.

¹⁰³ Captain Paul Johnston, "Canopy Glint: Reflections on Out of the Sun: Aerospace Operations for the Canadian Forces," *Air Symposium 2002: Air Force Command and Control*, ed. LCol (ret) Douglas L. Erlandson and Allan English (Winnipeg: Canadian Forces College and Canadian Forces Training Material Production Centre, 2002), 83-97. The document was rushed, had no publication number or date, and published in a unilingual format using a commercial printing company. *Out of the Sun* was rescinded in 2004.

¹⁰⁴ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine...*, 13.

¹⁰⁵ Allan English and Colonel John Westrop, *Canadian Air Force Leadership and Command: The Human Dimension of Expeditionary Air Force Operation...*, 49.

¹⁰⁶ Colin S. Gray, *Exploration in Strategy...*, 66.

doctrinal development is not an option for the future. This includes the development on explicit doctrine for AAR.

B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine* is a manual facilitating the development of key air power functions at the operational level. The doctrine uses the principles of war as the "fundamental guideline" for its development.¹⁰⁷

The table below outlines the principles of war from the CF Aerospace Doctrine:

SELECTION AND MAINTENANCE OF THE AIM	Every military operation must have a single, attainable, and clearly defined aim that remains the focus of the operation. The aim defines the operation; deviation from the aim dilutes effort and risks failure.
MAINTENANCE OF MORALE	Morale is the most important element in ensuring cohesion and the will to win. It is nurtured through good leadership, sound discipline, realistic training, confidence in equipment, and a sense of purpose.
OFFENSIVE ACTION	Distinct advantage lies with the offence because it confers the initiative, gives freedom of action, and compels the enemy to be reactive rather than proactive.
SECURITY	Security guards vulnerabilities and protects vital interests. It provides freedom to take offensive action and denies this advantage to an opponent.
SURPRISE	Surprise can produce results out of proportion to the effort expended. An opponent surprised is ill prepared, and unable to mount an effective opposition.
CONCENTRATION OF FORCE	It is essential to concentrate superior force at a decisive time and place. Forces should be disposed in a manner which permits them to combine quickly to deliver a decisive blow or to counter an enemy threat when and where required.

¹⁰⁷ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine...*, 23.

ECONOMY OF EFFORT	Resources are always limited, so they must not be wasted. To achieve maximum concentration at the main area of interest (AI), prudent risk may have to be accepted in other areas.
FLEXIBILITY	No plan can accommodate all factors of chance and opposition. Success requires the ability to alter plans to take advantage of opportunities or to counter difficulties.
COOPERATION	Cooperation among elements of a force maximizes its capabilities. It entails a unified aim, team spirit, interoperability, division of responsibility, and coordination of effort to achieve maximum effectiveness.
ADMINISTRATION	No plan or operation can succeed without adequate administrative and logistic support. Scarce resources and critical materiel must be controlled at the appropriate level of command. The most economic and effective use of materiel is required at all times.

Table 2.1¹⁰⁸

From the principles of war, the doctrine provides further amplification in terms of the tenets of air power. It is from these tenets that the RCAF doctrine can focus on the functions of air power of which AAR is a core role within air mobility. Although the CF Aerospace Doctrine attributes only a small paragraph to this role, it provides the basis for the development of that concept within the Move Doctrine manual.

Move Doctrine

Move Doctrine is a keystone manual inferring that it is subordinate to a higher level capstone manual.¹⁰⁹ Aerospace Doctrine (capstone manual) defines the missions and

¹⁰⁸ Ibid., 24.

¹⁰⁹ Ibid., 3. Capstone manual is a manual of overarching importance within a hierarchy of manuals that deals with the fundamental aspects of a broad subject matter. Keystone manual is a manual of seminal

tasks and the Move Doctrine is dedicated to the development of the air mobility mission as a whole, including both fixed wing and rotary wing capabilities. Move Doctrine defines its role as "the sub-function that exploits global reach and speed of aerospace power to rapidly deploy and position personnel and material to achieve the desired effect."¹¹⁰ Move Doctrine highlights a number of fundamental tenets, and within those tenets is a reference to the intrinsic value of AAR as both a force enabler and a force multiplier, permitting the receiver to extend its range, payload, persistence and flexibility.¹¹¹ Move Doctrine defines AAR as "the capability to refuel aircraft in flight, which includes both AAR and helicopter in-flight refueling (HIFR)."¹¹² Although somewhat convoluted, the better context would have been to define AAR as the capability to refuel in-flight all fixed and rotary wing aircraft. From that definition one could have identified the secondary roles as Fixed Wing Air Refueling (including large aircraft not just fighters) and Helicopter Air Refueling.¹¹³ Of particular interest is the inclusion of HIFR, as the document further elaborates that it is not a "tasked mission in the doctrinal sense and therefore not part of the RCAF functions."¹¹⁴ The capstone doctrine manual does not restrict the function of AAR and nor should the keystone Move Doctrine. Current economic realities and policies may restrict the concept of HIFR but not doctrine. Therefore, the section on AAR is incomplete and should have delved further into the potential benefits of the HIFR role.

importance under an overarching capstone manual within a hierarchy of manuals that deals with the fundamental aspects of a broad subject matter. *Ibid.*, 63, 67.

¹¹⁰ Department of National Defence, B-GA-404-000/FP-001, *Canadian Forces Aerospace Move Doctrine...*, 1.

¹¹¹ *Ibid.*, iv. Force Multiplier is a capability provided to a force that enhances the probability of success in mission accomplishment. Force Enabler is a capability provided to a force that is essential to mission accomplishment. *Ibid.*, 67.

¹¹² *Ibid.*, 30.

¹¹³ As a former exchange pilot with the USMC flying the KC-130J, those terms were congruent with Marine Air Refueling operations.

¹¹⁴ Department of National Defence, B-GA-404-000/FP-001, *Canadian Forces Aerospace Move Doctrine...*, 30.

Chapter 3 will highlight the fundamental advantages of the HIFR role in extending helicopter range and endurance.

The Move Doctrine emphasizes that AAR is "essential for performing Canadian sovereignty missions as well as for conducting global air expeditionary operations."¹¹⁵ It also argues convincingly that "AAR is a force enabler, a force multiplier, or both depending on the mission conducted."¹¹⁶ The Move Doctrine provides the operational level argument on the value of AAR and leaves little doubt on the utility of that role, providing a clear rationale as to why this capability is essential to the defence of Canada and expeditionary RCAF operations.

Conclusion

This chapter demonstrated the importance of the AAR role to the RCAF by first reviewing the works of Clausewitz, Douhet, Trenchard and Mitchell. Clausewitz's work, which is almost two hundred years old, still serves as the foundation for most western military doctrine and the *Canadian Forces Aerospace Doctrine* is no exception. Douhet, Trenchard and Mitchell have all provided the basic concepts and premises from which air power could evolve. Their basic message on the need to control the air to win a war still rings true and it is within those theories that the application of AAR as a core role has merit. AAR provides the means to extend the range and persistence to aircraft, essential in the conduct of air operations aimed at controlling the air.

¹¹⁵ Ibid., 30.

¹¹⁶ Ibid., 35.

The RCAF has, for the better part of its existence, been very nonchalant with the development of doctrine. The employment of air power requires unity of effort only found in doctrine. The advent of CFAWC provides the RCAF with the authoritative means for the continuous development of the aerospace doctrine series. It is that very process the RCAF must utilize in order to justify the need for the revitalization of the AAR fleet. The strategic and operational doctrines emphasize the essential role that AAR plays in the prosecution of air power operations. The failure to highlight the prominence of the AAR role as a force multiplier and force enabler will be a major blow to the RCAF's operational relevance in future domestic and international operations. The next two chapters will further explore the doctrinal concept of AAR and its utility in domestic and expeditionary operations.

CHAPTER 3: National Sovereignty Operations

Canada is a Northern nation. The North is a fundamental part of our heritage and our national identity and it is vital to our future.

– Chuck Strahl, P.C., M.P. Minister of Indian Affairs and Northern Development

The Oxford dictionary defines national sovereignty as the "authority of a state to govern itself or another state."¹¹⁷ In a country as vast as Canada, the sovereignty challenge has always been great: Canada has a very small population to ensure that the borders are secure from outside threats. The challenge is even greater when one considers the majority of Canada's population lives near its southern border encompassing only a fraction of the country, while the rest of the country is sparsely populated and difficult to reach due to its distances and lack of transportation nodes. The most efficient way to reach these remote locations is by aircraft, thus making the RCAF the most capable regular force service to provide a semblance of sovereignty year-round.¹¹⁸ The provision of this capability is assured through the active participation in Northern Sovereignty Operations (NSO), maritime domain awareness patrols, support to the Canadian Rangers and Search and Rescue (SAR).

Limited in terms of resources (personnel and assets), the RCAF lacks the ability to provide a sustained and persistent presence in its current composition. The existing resource challenges will be further exasperated if the climate change theories hold true and open up the Arctic. What was once impenetrable could become a land of exploration

¹¹⁷ Oxford Dictionary, *Definition of Sovereignty*, last modified [or accessed] March 23, 2015 <http://www.oxforddictionaries.com/definition/english/sovereignty>

¹¹⁸ Government of Canada, Canadian Army, "About the Canadian Rangers," last modified [or accessed] 14 April 2015, <http://www.army-armee.forces.gc.ca/en/canadian-rangers/about.page>; the Canadian Rangers a sub-component of the CAF reserves. Numbering approximately 5,000, they provide patrols and detachments for national-security and public-safety missions in sparsely settled northern, coastal and isolated areas of Canada that cannot conveniently or economically be covered by other parts of the CAF.

and exploitation of natural resources (oil and gas), commerce (shipping) and increased tourism (cruise ships). These potential issues will all pose a significant challenge to Canada in terms of willingness and cost associated with defending the Arctic. Christian Le Miere and Jeffrey Mazo in *Arctic Front: Defending Canada in the Far North* put it into perspective: "Canada has never embraced the North beyond symbolism and mythology."¹¹⁹ Canadians have been complacent when it comes to defending its northern border, and the new realities associated with the re-emergence of a bellicose Russia will pose additional security challenges to the Arctic. This chapter will look at the challenges associated with protecting Canada's Arctic sovereignty through the lenses of the RCAF and more specifically the role that AAR should play in that future endeavour.

Climate

Climate change has been a "hot" topic of debate for the past decade, as man-made gases in the form of CO₂ have caused the earth's climate to change at varying degrees due to the trapped gases warming earth's atmosphere. This has been especially significant in the Arctic, where the changes have been the most noticeable. On February 25, 2015, the National Snow and Ice Data Center calculated that the extent of the Arctic sea ice was the lowest on record (records have been kept since 1981).¹²⁰ The National Oceanic Atmospheric Administration announced recently that 2014 was the warmest year on record and "since 1880, Earth's average surface temperature has warmed by about 0.8 degrees Celsius, a trend that is largely driven by the increase in carbon dioxide...the

¹¹⁹ Ken S. Coates et al., *Arctic Front: Defending Canada in the Far North* (Toronto: Thomas Allen Publishers, 2008), 7.

¹²⁰ National Snow & Ice Data Center, "Arctic Sea Ice Reaches Lowest Maximum Extent on Record," last modified [or accessed] 23 March 2015, <http://nsidc.org/arcticseaicenews/>

majority of that warming has occurred in the past three decades."¹²¹ These dire announcements indicate that the Arctic is liable to see significant changes to its current eco-system and the potential for a more hospitable Arctic will in all likelihood see an increase in oil and gas explorations, shipping and tourism. Other issues include potential ecological disaster, maritime disaster and more challenges to the current Exclusive Economic Zone (EEZ).¹²²

The 2015 index of US Military Strength by the Heritage Foundation outlines the security implications for the Arctic due to climate change stating that "it could conceivably create natural disasters, exacerbate conflicts, and make the operating environment for U.S. armed forces more difficult."¹²³ Canada may see greater confrontation to its claim "that the waters within the Arctic Archipelago, including the waters of the Northern Passage are historical internal waters."¹²⁴ It is impossible to predict when the Arctic will be free from ice, but it is a very likely possibility that Canadian Arctic sovereignty will be challenged by a number of international actors. For that issue alone, Canada must be prepared to defend its interests: a sovereign Canada will need a capable and well equipped RCAF able to respond quickly and effectively to the growing foreign presence in the Arctic.¹²⁵ The ability for the RCAF to be that deterrence

¹²¹National Oceanic and Atmospheric Administration, "Arctic Change," last modified [or accessed] 23 March 2015, <http://www.arctic.noaa.gov/detect/global-temps.shtml>

¹²² OECD, "Exclusive Economic Zone" last modified [or accessed] 14 April 2015, <https://stats.oecd.org/glossary/detail.asp?ID=884>; the Exclusive Economic Zone (EEZ) comprises an area which extends either from the coast, or in federal systems from the seaward boundaries of the constituent states (3 to 12 nautical miles, in most cases) to 200 nautical miles (370 kilometres) off the coast.

¹²³ The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 21, last modified [or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

¹²⁴ Ted L. McDorman, "Canada's Ocean Jurisdiction in the Arctic: An overview of Maritime Boundary Issues," in *Thawing Ice -- Cold War: Canada's Security, Sovereignty, and Environmental Concerns in the Arctic*, ed. Rob Huebert, 11 (Winnipeg: Centre for Defence and Security Studies, 2009).

¹²⁵ Ferry de Kerckove, *The Strategic Outlook for Canada: The Eclipse of Reason 2015* (Vimy Paper. Ottawa, Canada: Canadian Defence Associations Institute, 2015), 26.

requires AAR to provide a level of reach and speed that can only be achieved with long-range fighter missions (beyond the normal unrefueled range). Delays in responding to threats due to the unavailability of AAR may undermine Canada's sovereignty claims to the Arctic.¹²⁶

Oil and Gas



Figure 3.1 depicts the territorial claims by the various Arctic nations¹²⁷

¹²⁶ Elisabeth Elliot-Meisel, "Arctic Security in the 21st Century: Compromise and Cooperation in the Northwest Passage" in *Thawing Ice – Cold War: Canada's Security, Sovereignty, and Environmental Concerns in the Arctic* ed. Rob Huebert, Centre for Defence and Security Studies University of Manitoba. (Winnipeg: Contemporary Printing Ltd., 2009), 27.

¹²⁷ Jeremy Bender "This map shows the massive scale of Russia's planned fortification of the Arctic", *Business Insider*, March 17 2015, last modified [or accessed] 25 March 2015, <http://www.businessinsider.com/chart-of-russias-fortification-of-the-arctic-2015-3>

Estimated to account for approximately 13% of the world's undiscovered oil and 30% of its gas, these Arctic resources estimates do not take into account the current discovered fields which make up another 10% of all world hydrocarbon deposits.¹²⁸ The economic realities of the Arctic could soon be the arena of potential territorial disputes as depicted by the shaded areas in the Figure 3.1. The United Nations Convention on the Law of the Sea (UNCLOS), an agreement with a goal of encouraging a diplomatic resolution,¹²⁹ gave each nation 10 years to stake their claim following ratification (Canada ratified the treaty in 2003¹³⁰). Canada's claim to these riches is no small feat and the challenges associated with those claims were an enormous scientific undertaking by Canada. Conducting the research allowed Canada to substantiate its Arctic continental shelf claims to UNCLOS.¹³¹ If, in the eventual decision, the UN were to award Canada's claim to the EEZ for the vast Arctic, the next massive undertaking would be to provide the means to patrol and protect Canada's interests. This clear direction taken from *Canada's Northern Strategy* provides the context: "The Government of Canada is firmly asserting its presence in the North, ensuring we have the capability and capacity to protect and patrol the land, sea and sky in our sovereign Arctic territory."¹³² It is conceivable that the Royal Canadian Navy would potentially have the capability to undertake patrols during parts of the year (mainly summer months) with its planned acquisition of up to six

¹²⁸ Christian Le Miere and Jeffrey Mazo, *Arctic Opening: Insecurity and Opportunity* (New York: Routledge, 2013), 35.

¹²⁹ Ibid.

¹³⁰ National Defence, "The Canadian Arctic Waters and UNCLOS", last modified [or accessed], March 28 2015, <http://www.forces.gc.ca/en/about-reports-pubs-military-law-strategic-legal-paper/naval-ops-arctic-waters-unclos.page>

¹³¹ Government of Canada, *Canada's Northern Strategy: Our North, Our Heritage, Our Future...*, 12.

¹³² Ibid., 9.

Arctic patrol vessels.¹³³ However, the ability to provide a continuous year round presence in the region would be left up to the RCAF and the Canadian Rangers.

Long range patrols would be limited to aircraft such as the CP-140 Aurora¹³⁴ or future unmanned aerial vehicles (UAV). However, neither aircraft currently have the ability to enforce Canadian airspace sovereignty through kinetic means.¹³⁵ The only platform capable of providing the enforcement of Canadian sovereignty is the fighter aircraft. Using an approximate combat radius of 250-500nm,¹³⁶ fighters can only patrol a very small area of the Beaufort Sea before turning back to Inuvik, which is the most northerly FOL in the west of Canada. AAR can enable that same mission and provide the range and persistence required for Canada to assert its sovereignty.

Canada is defending its claim through the UNCLOS process regarding what it perceives as its EEZ, but the underlying issue is that it has yet to commit to securing this area. This is especially the case considering that only Canada and Russia chose to refuse to accept a portion of Article 298:

With regard to Article 298, paragraph 1 of the Convention on the Law of the Sea, Canada does not accept any of the procedures provided for in Part XV, section 2, with respect to the following disputes:

¹³³ David Pugliese, Defense News, "Canada Kicks off Arctic Patrol Ship Program," last modified [or accessed] March 28, 2015, <http://www.defensenews.com/story/defense/naval/ships/2015/01/25/canada-arctic-offshore-patrol/22153853/>

¹³⁴ Royal Canadian Air Force, "CP-140 Aurora: Intelligence, Surveillance and Reconnaissance Aircraft," last modified [or accessed] 14 April 2015, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cp-140.page>

¹³⁵ Vachon L. "Véhicules Aériens sans Pilote pour assurer la Souveraineté de L'Arctique: Est-ce Nécessaire et Faisable?" Masters In Defence Studies, Canadian Forces College, 2013. Current UAVs are only capable of air-ground kinetic operations. The Arctic poses a number of issues for long range UAV's due to the poor communications available at present.

¹³⁶ Jane's Online, "Boeing (McDonnell Douglas) F/A-18 Hornet", last modified [or accessed] 4 April 2015, https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1337873&PUBABBREV=JAU_ Due to the large number of factors that affect combat radius, this paper is taking an average figure for the CF-188. Combat radius, refers to the distance the aircraft can travel to target and return to base with sufficient fuel.

- Disputes concerning the interpretation or application of articles 15, 74 and 83 relating to sea boundary delimitations, or those involving historic bays or titles;
- Disputes concerning military activities, including military activities by government vessels and aircraft engaged in non-commercial service, and disputes concerning law enforcement activities in regard to the exercise of sovereign rights or jurisdiction excluded from the jurisdiction of a court or tribunal under article 297, paragraph 2 or 3;
- Disputes in respect of which the Security Council of the United Nations is exercising the functions assigned to it by the Charter of the United Nations, unless the Security Council decides to remove the matter from its agenda or calls upon the parties to settle it by the means provided for in the Convention.¹³⁷

Both Canada and Russia have preached a measure of cooperation until now.¹³⁸ However, considering that both nations have refused to accept the UNCLOS binding arbitration process, Canada cannot discount a more robust challenge from Russia if it was to disagree with any of the terms set forth. In that eventuality, the RCAF will need to be prepared to assert Canada's sovereignty and without tanker support, armed patrols using fighters will not be possible due to the vastness of the Arctic and the lack of useable airports.

Russia

In a recent article in *Defense News*, Mathew Bodner states "with the Arctic becoming increasingly contested, and Russia's economy continuing its deep dependence on resource exports, Moscow has been beefing up its military presence in the region to

¹³⁷ UNCLOS, "Declarations and statements," last modified [or accessed], March 28 2015. http://www.un.org/depts/los/convention_agreements/convention_declarations.htm#Canada The Russian declaration is comparable to the Canadian declaration quoted in the paper, the exact response is found in the link provided. Last modified [or accessed] 28 March 2015, http://www.un.org/depts/los/convention_agreements/convention_declarations.htm#Russian_Federation Upon ratification

¹³⁸ Government of Canada, *Canada's Northern Strategy: Our North, Our Heritage, Our Future...*, 33.

assert control over as much territory as it can."¹³⁹ The demise of the Soviet Union brought a relative calm to Russian Arctic ambitions for the reason that they had no choice but to turn inward in order to re-establish some semblance of statehood. Russia's military was in a shambles and the capability it boasted during the Soviet era was all but gone. Fast forward 25 years and a re-invigorated Russia has outwardly signaled its intention on the Arctic. On March 16, 2015, Russian President Vladimir Putin ordered the launch of a large five-day military exercise in the Arctic. This snap exercise involved thousands of personnel including army, naval and air components. The intent was to showcase Russia's capability to not only react quickly to potential threats but to display their prowess at conducting Arctic operations. In an interview with reporter Murray Brewster, Admiral William Gortney, the Commander of NORAD said: "What I'm just never certain about is: What is their intent?"¹⁴⁰ There is a renewed military interest in the Arctic and for good reason. Russia has been passive for too long; under the iron fist of Vladimir Putin, their intentions are clear: stoke the flames of the Russian nationalist pride and re-invigorate Russia's status as a major international player. Since 2008, Russia has increased its defence spending by 30 percent,¹⁴¹ whereas the CAF has seen its budget shrink by 13 percent from 2009.¹⁴²

¹³⁹ Mathew Bodner, "Moscow Revamps, Re-opens Former Soviet Bases To Claim Territories" Defense News, March 11 2015, Last modified [or accessed] March 28 2015,

<http://www.defensenews.com/story/defense/policy-budget/warfare/2015/03/11/russia-arctic-bases-soviet-northern-command-navy-fleet-siberian-island/24335619/>

¹⁴⁰ Murray Brewster, *Russia Launches Large scale military manoeuvres in the Arctic*, The Canadian Press, 16 Mar 2015. <http://www.ctvnews.ca/world/russia-launches-large-scale-military-manoevres-in-the-arctic-1.2281388>; Internet, accessed 16 March 2015.

¹⁴¹ The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 31, last modified[or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

¹⁴² J.L. Granastein, "How the Harper government lost its way on defence spending," *The Globe and Mail*, Oct 01 2014, last modified [or accessed], March 29 2015, <http://www.theglobeandmail.com/globe-debate/how-the-harper-government-lost-its-way-on-defence-spending/article20859264/>

In one aspect Russia is intent on developing the Arctic through cooperation but in another the country displays its military muscle by running large scale exercises and planning to re-open up to seven of the mothballed Cold War era airbases throughout the Arctic.¹⁴³ Canadian Arctic expert Rob Huebert states "Canada needs the means to identify and respond to foreign actions in its Arctic territory."¹⁴⁴ The statement is congruent with the need to confront Russia's audacious attitude with similar capabilities. Ensuring that the RCAF is appropriately equipped to operate in the vast expanses of the Arctic and respond in kind is fundamental to Canadian sovereignty. In the 2011 Annual Planning Directive, the commander of the RCAF considered Arctic operations his second highest priority: "For in-service capabilities, force generation emphasis must be given to developing the Air Force's ability to operate in the Arctic."¹⁴⁵ Based on those arguments, investment in AAR becomes critical due to the large distances and the limited infrastructure available.

The exercise mentioned above is but a subset of what the Russian Northern Command has planned over the next ten years. As depicted in Figure 3.2, the expansion plans of the Russian military are quite dramatic, especially if we contrast it to the Canadian side of the Arctic and see the lone FOL on the western side (Inuvik). Jeremy Bender states unequivocally that, when compared to the other Arctic nations, "only

¹⁴³ RIA Novosti, "Russia to Set-up Arctic Military Command by 2015," Feb 20 2014.

<http://en.ria.ru/russia/20140217/187620827/Russia-to-Set-Up-Arctic-Military-Command-by-2015.html>

¹⁴⁴ Rob Huebert "Arctic 2030: What are the consequences of climate change?: The Canadian response." *Bulletin Of The Atomic Scientists* 68, no. 4: (2012), 21. EBSCOhost, accessed April 14, 2015,

<http://search.ebscohost.com/login.aspx?direct=true&db=eih&AN=77756688&site=ehost-live>

¹⁴⁵ Department of National Defence, Chief of the Air Staff, *Commander Air Command Annual Planning Directive*, June 30 2011, 5. His first priority was to effectively assist transition of the mission in Afghanistan. Reconstituting repatriated forces and realigning capabilities to enable sustainable operational excellence both at home and abroad.

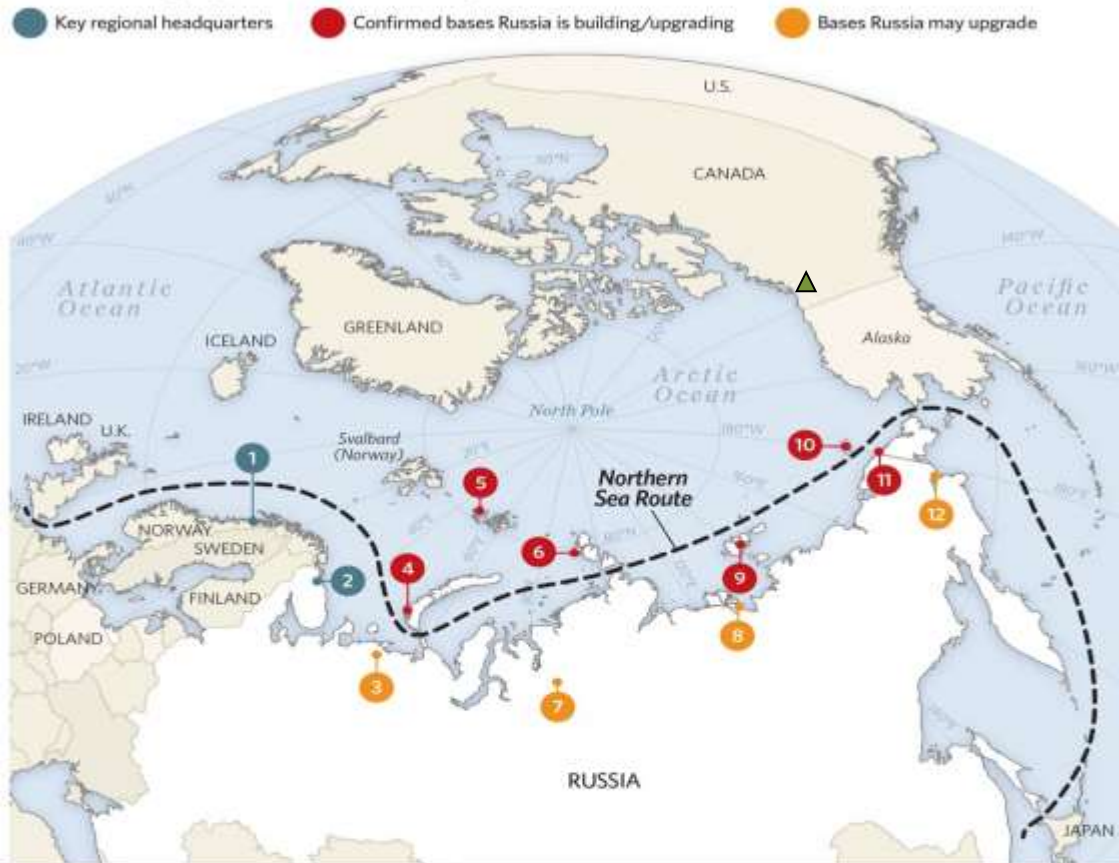
Russia has taken the additional step of completely militarizing its Arctic frontier."¹⁴⁶ He further amplifies that the Russian Air Force will have an additional 10 airfields that will be able to accommodate their future bomber, expected to be in service by 2025.¹⁴⁷ The need to expand Canada's northern infrastructure should be compared to what the Russian military is planning to accomplish in terms of Arctic presence.

¹⁴⁶ Jeremy Bender "This map shows the massive scale of Russia's planned fortification of the Arctic", Business Insider, March 17 2015, last modified [or accessed] 25 March 2015, <http://www.businessinsider.com/chart-of-russias-fortification-of-the-arctic-2015-3>

¹⁴⁷ Ibid.

MAP 2

Russia Fortifying Bases in Arctic Region



Key Locations

- | | |
|--|-----------------|
| 1 Bodo, Norway's National Joint Headquarters | 6 Sredny Ostrov |
| 2 Severomorsk, home of Russia's Northern Fleet | 7 Alykel |
| 3 Naryan-Mar | 8 Tiksi |
| 4 Rogachevo | 9 Temp |
| 5 Nagurskoye | 10 Zvyozdny |
| | 11 Mys Shmidta |
| | 12 Ugolny |

▲ INUVIK FOL

Source: Heritage Foundation research.

Figure 3.2¹⁴⁸

The Russian military nuclear triad includes Intercontinental Ballistic Missiles (ICBM) Sea Launched Ballistic Missiles (SLBM) and Air Launched Cruise Missiles

¹⁴⁸ The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 163, last modified [or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

(ALCM). The last of these is the major concern for the RCAF, as it is the one which directly confronts Canada's Arctic defence. The ALCMs are launched from Russia's existing strategic bomber force; the TU-95 Bear H and the TU-160 Blackjack bombers.¹⁴⁹ The Tu-95, a four engine turbo prop manned aircraft capable of inflight refueling is the primary Russian bomber.¹⁵⁰ Defeating and/or deterring the bomber's ability to launch cruise missiles at vital infrastructure is critical to Canadian defence. Distances required for fighter intercept of this threat directly correlate with the central role of AAR (recall the Avro Arrow discussion in Chapter 1). In other words, AAR becomes a mission enabler: without AAR, fighters based in Cold Lake cannot intercept incoming bombers, clearly demonstrating the range limitation associated without refueling.¹⁵¹

The need for AAR in this critical air defence role that the CFDS articulates as one of the CAF's primary responsibilities (NORAD) is of the utmost importance. Figure 3.3 provides a graphical representation of the current and future cruise missile range capability in the Russian arsenal. The Russian Air Force currently has two cruise missiles in its inventory both capable of conventional and nuclear strike: the KH-55SM and the KH-101. The KH-55SM "Kent" is the current cruise missile and has a maximum distance

¹⁴⁹ Marlene Laruelle, *Russia's Arctic Strategies and the Future of the Far North* (New York: M.E. Sharpe, 2014), 125.

¹⁵⁰ Jane's Online, "Tupolev Tu-95 and Tu-142," last modified [or accessed] 23 March 2015, https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1337856&Pubabbrev=JAU_, The Tu-160 Bomber is similar to a B-1 and the Russian Air force only has 16 in its inventory.

¹⁵¹ Jane's Online, "Boeing (McDonnell Douglas) F/A-18 Hornet", last modified [or accessed] 4 April 2015, https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1337873&Pubabbrev=JAU_ Due to the large number of factors that affect combat radius, this paper is taking an average figure of 500nm for the CF-188. Combat radius refers to the distance the aircraft can travel to target and return to base with sufficient fuel.

of 3000km (yellow circle) with an accuracy of 25m.¹⁵² Expected to be operational in the near future is the stealthy KH-101. Jane's predicts the KH-101 to have a maximum range of 5000km¹⁵³ (red circle), far surpassing the current distance required to complete those intercepts when compared to the KH-55SM. What the graphical depiction further highlights that in order to defeat or deter a Russian bomber armed with the KH-101 prior to reaching a point that it could launch a cruise missile strike on Ottawa, the intercept would have to be at least 900km north of Inuvik, beyond the estimated combat radius of the CF-188 without AAR (blue circle).¹⁵⁴ The RCAF will only challenge this future stand-off capability of the Russian long range bombers if it maintains its own organic air refueling capability. Without the AAR role, Canada becomes dependent on the US for defence of the north.



Figure 3.3

¹⁵² IHS Jane's "Air Launched Weapons- KH55SM," last modified [or accessed] 23 March 2015, <https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1306760&Pubabbrev=JALW>

¹⁵³ IHS Jane's "Air Launched Weapons- KH101", last modified [or accessed] 23 March 2015, <https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1306760&Pubabbrev=JALW>

¹⁵⁴ Ibid.

Under NORAD, the US provides AAR to the RCAF in the Arctic approaches. Canada is a partner in NORAD, but it is not an equal partner in terms of resources providing a token defence commitment to North American security.¹⁵⁵ The challenge is that Canada cannot entirely rely on the United States for AAR, as the USAF will be facing increasing resource pressures with its own AAR fleet in the near future. Case in point, the purchase of 179 KC-46A (B767-2C variant) by the USAF reduces their overall tanker fleet, replacing only 33 percent of the existing 400+ KC135s.¹⁵⁶ The current purchase of 179 KC-46A will not be completed until 2028,¹⁵⁷ putting an immense pressure on the remaining fleet of US tankers (the KC135 has an average age of 51 years).¹⁵⁸ It is conceivable that the current NORAD arrangement will not be sustainable in the future, and so Canada should re-invest in its own AAR capability instead of relying on the US tankers. The potential exists when the US will face its own shortage of tankers for other missions of equal importance to their defence, leaving the RCAF “high and dry.”

Critics argue that there is no Arctic military menace and that there are better ways to spend Canadian Tax dollars. Ian G. Brosnan, Thomas M. Leshine and Edward L. Miles argue in *Cooperation or Conflict in a Changing Arctic? Opportunities for Maritime cooperation in Arctic National Strategies* that the focus should be on cooperation and the current emphasis on potential conflict can be resolved.¹⁵⁹ However, cooperating on Arctic

¹⁵⁵ See the discussion on “defence against help” in the Introduction.

¹⁵⁶ Dave Majumdar, "The Quest for the next generation tanker," 23 March 2015. <http://www.flightglobal.com/Features/tankers-special-report/Boeing-KC-46/>,

¹⁵⁷ Ibid., 23 Mar 2015.

¹⁵⁸ The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 256, last modified[or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

¹⁵⁹ Ian G. Brosnan, M. Leshine and Edward L., "Cooperation or Conflict in a Changing Arctic? Opportunities for Maritime cooperation in Arctic National Strategies,' in *The Fast Changing Arctic: Rethinking Arctic Security for a Warmer World*, ed. Barry Scott Zellen, 83-102 (Calgary: University of Calgary Press, 2013), 97.

matters is only one aspect: Canadians cannot look at the Arctic sovereignty issue as a single entity. This limited view would not take into consideration the greater geopolitical challenges that may push Russia to retaliate from its Arctic bases. As alluded to by the Heritage Foundation, "the Arctic remains peaceful and the threat of armed conflict is low, but Russian designs on the region might someday threaten its stability."¹⁶⁰ Any action by NATO that Russia would consider to be a provocation in its sphere of influence, (i.e., Ukraine and the Baltic region) may lead them to launch a retaliatory attack on North America.¹⁶¹ Canada must be cognizant of this reality and ensure a deterrence capability is available at all times. The availability of a RCAF tanker becomes a critical enabler to this mission as reliance on US support can no longer be a primary plan of action.

SAR and Major Disasters

With the onset of climate change, more activity is bound to happen in the Arctic. The Heritage Foundation's recent 2015 report describes the Pentagon's assessment on the future operating environment: "the Arctic and the assumed increased role in humanitarian assistance and relief that it expects to be caused by 'climate change-induced' disasters."¹⁶² With the increase in activity, the number of SAR call-outs to the Arctic will also increase and one of the biggest challenges to SAR is the time required to get to the scene. CF Move Doctrine considers response time "the most essential characteristic of

¹⁶⁰ The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 115, last modified[or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

¹⁶¹ Brian Stewart, "Putin gets Payback for Canada's anti-Russia stance" CBC News, 27 June 2014, last accessed [or modified] 13 April 2015, <http://www.cbc.ca/news/politics/putin-gets-payback-for-canada-s-anti-russia-stance-brian-stewart-1.2688655>

¹⁶² The Heritage Foundation, ed. by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 21, last modified[or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf

SAR."¹⁶³ The faster one can get to the scene, the greater likelihood one can make a difference and potentially save lives. In March 2011, during a proceeding of the Standing Senate Committee on National Security and Defence, "Witnesses made two basic observations about search and rescue in the Arctic. First, the need is on the rise. Second, response times are potentially too slow given that CAF SAR air assets are based almost entirely in southern Canada."¹⁶⁴ All current Canadian SAR squadrons are located on the coasts or in the south; there is no primary SAR support in the Arctic. A response to an Arctic SAR call-out comes from either Winnipeg or Trenton (the Arctic is the responsibility of the Trenton SAR Region) where squadrons operate the CC-130 aircraft. To complete the "rescue" part of SAR requires a helicopter with an ability to extract the victims. The only long range SAR helicopter in the RCAF inventory is the CH-149 Cormorant, a variant of the Augusta Westland EH-101 currently based in three locations: Comox (West coast), Gander, and Greenwood (East coast).¹⁶⁵ Although the Cormorant has a decent range and speed, the aircraft requires a number of stops to get to a SAR call-out in the high Arctic.

A recent example of such a scenario occurred in June 2013, on Admiralty Inlet near Arctic Bay, Nunavut. Twenty tourists were trapped when the ice they were on broke off from the main land. At or around 7am Tuesday June 25, 2013, the rescue effort got underway and a CC-130 based in Winnipeg arrived on-scene midday, but was only able to air drop supplies to the group. At the same time, a Cormorant helicopter was launched

¹⁶³ Department of National Defence, *Canadian Forces Aerospace MOVE Doctrine...*, 49.

¹⁶⁴ Government of Canada, Standing Senate Committee on National Security and Defence, "Sovereignty and Security in Canada's Arctic; interim report" March 2011, 11.

¹⁶⁵ Jane's Online, last modified [or accessed] April 14 2015, <https://janes.ihs.com>, all aircraft data were derived from Jane's online. The RCAF also has the most modern Chinooks in the world capable of extended range due to the additional fuel tanks. However those aircraft have not been assigned a primary SAR role and would only be used during a major disaster response.

in order to extricate the tourists from their location. The Cormorant did not reach the tourists until Wednesday, more than 24 hours after the call for help.¹⁶⁶ Although this story had a positive outcome, it is highly likely that had the ice floe broken up and twenty people had perished, the spotlight would have been directly on the RCAF's inability to reach the stranded tourists in a timely manner. The table below compares the same scenario with a Cormorant outfitted with an AAR capability:

Distance (NM)	AAR Capable Aircraft (1)	Non-AAR Capable Aircraft (2)
1658	Gander - Arctic Bay 11 hours 18 minutes	Approx. time to Arctic Bay: 30 Hours

Table 3.1¹⁶⁷

The result of the comparison provides ample evidence as to the incredible advantage that AAR provides to a Rotary Wing (RW) SAR response in the Arctic. In a statement to the Standing Senate Committee on National Security and Defence, Professor Michael Byers stated that if we want to be an "Arctic power" we need to be able to respond to SAR call-outs 'in a very timely fashion.'¹⁶⁸ Even though others may argue that the real solution would be to permanently base SAR units in the north, the cost of such a measure in terms of infrastructure, personnel and equipment is prohibitive.¹⁶⁹ A more palatable solution is to enhance the RCAF's AAR capability thus providing an

¹⁶⁶ CBC News, "tourists Stranded on Arctic Ice Floe get Supply Air Drop," <http://www.cbc.ca/news/canada/north/tourists-stranded-on-arctic-ice-floe-get-supply-air-drop-1.1324061>

¹⁶⁷ EH-101 technical data, last modified [or accessed], March 28, 2015 <http://www.aerospace-technology.com/projects/aw101-transport-helicopter/>. All flight distance/time data were derived from Ascend Flight Manager, last modified [or accessed], March 28 2015 <http://www.flightmanager.com/content/TimeDistanceForm.aspx>

¹⁶⁸ Government of Canada, Standing Senate Committee on National Security and Defence, "Sovereignty and Security in Canada's Arctic; interim report" ..., 12.

¹⁶⁹ Dany Poitras, " Search and Rescue in the Arctic: A Myth or Reality" (Masters in Defence Studies, Canadian Forces College, 2013), 79.

improvement on the current response time for RW and in turn eliminating some of the challenges with flying in the Arctic.¹⁷⁰

In his annual 2011 Directive, the Chief of Defence Staff (CDS) highlighted the very notion of an increase in the potential for a major disaster by stating "an increasingly open North could have security challenges and events requiring consequence management."¹⁷¹ For the CAF, the definition of consequence management is the response to other government departments (OGDs) in the case of natural or man-made disasters. The details to the CAF's response to major disasters are in a number of contingency plans and are beyond the scope of this study. A simplified explanation is: following a primary response to a disaster, the on-scene commander (be they OGDs, SAR response, provincial authorities, etc...) can declare the area as a major disaster and request the support of the CAF which in turn would activate a plan to move assets and equipment in support of the rescue operation. In the case of a remote area response such as the Arctic, air mobility aircraft (CC-177 and CC-130) with personnel and equipment will fly north and air drop much needed supplies. Due to the very recent acquisition of the Chinook helicopter, and its ongoing operational development, the current plan has not taken into account this new airlift capability.¹⁷² However, as the operational envelope expands, there is the potential for the aircraft to be configured with an AAR probe. This capability would provide the RCAF with a helicopter able to reach the farthest northern

¹⁷⁰ Ibid., 57. He identifies three factors affecting RW response to an Arctic SAR mission: Distance, refueling stops and weather. In addition, one needs to consider the added risk of mechanical breakdowns when stopping.

¹⁷¹ Department of National Defence, Chief of Defence Staff, *CDS Directive for the DND in Canada's North*, April 21, 2011, 3.

¹⁷² Department of National Defence. *Canada Command CONPLAN 10250/10 MAJAID – CF Response to a Major Air Disaster* (Ottawa: Commander Canada Command, 2010) Current MAJAID plan does not involve the CH-147. However, the Canadian Joint Operations Command (CJOC) J-5 is in the process of revising the plan to include the CH-147.

point without the need to stop. In its current configuration, the Chinook will have to stop and refuel on a number of locations prior to reaching the high Arctic. The table below outlines a hypothetical situation tasking the Chinook to respond to a Major Disaster in the high Arctic (Using Resolute Bay Airport) from its current base in Petawawa ON. The table below depicts the difference between an air-refueled Chinook reaching its intended target and one without the AAR advantage:

Distance (NM)	AAR Capable Aircraft (1)	Non-AAR Capable Aircraft (2)
561		Petawawa- Kuujjuarapik 4 Hour 30 Minutes
562		Kuujjuarapik- Coral Harbour 4 Hours 30 Minutes
280		Coral Harbour - Hall Beach 2 Hours 22 minutes
440		Hall Beach - Resolute Bay 3 hours 33 minutes
Total: (1) 1790 (2) 1843	Total air time: 13:43	Total air time: 14:55 Total time: 18:55

Table 3.2¹⁷³

There are also a number of risks associated with the non-refueled scenario, including the weather, mechanical breakdowns and crew day: in this example, the CH-147 crew would run out of crew day in Hall Beach necessitating a minimum 10 hours of crew rest (normal crew rest is 12 hours) prior to recommencing flight operations.¹⁷⁴ Although some of the same challenges could affect the air refueled aircraft, the risk is

¹⁷³ Average Cruise speed for CH-147 is 133 knots with a maximum endurance of approximately five hours in the high Arctic due to the remoteness of available landing sites. Every stop requires an average of one hour to refuel at an airport, six hours at a fuel cache. The CH-147 would need to be refueled in Resolute in order to support the mission (included in the total time). Data derived with the help of Subject Matter Expert and from C-12-147-F00/MB-001 - MHLH AIRCRAFT OPERATING INSTRUCTIONS. All flight distance/time data were derived from Ascend Flight Manager, last modified [or accessed], March 28 2015 <http://www.flightmanager.com/content/TimeDistanceForm.aspx>

¹⁷⁴ 1 Canadian Air Division Orders, RCAF Flight Operations Manual, effective 21, March 2015, Annex 2.3.3.2.G 1/1. The additional time would be added to the table, increasing it to approximately 29 hours.

much lower.¹⁷⁵ Finally, the AAR mission would enable the CH-147 crew to conduct operations on that same day, potentially contributing to lives saved.

Conclusion

The CFDS states that operations in defence of Canada are the number one mission for the CAF. In that vein, the government should want to equip the CAF in order to ensure mission success in every region of the country and AAR is part of that requirement. As clearly demonstrated, the Russian military is not standing pat, nor is its government; they are actively pursuing a re-militarization of their Arctic frontier with new bases capable of supporting current and future air power capabilities. Russian bombers with their advanced cruise missiles will have a distinct advantage of being able to launch a pre-emptive strike unless Canada invests in its own deterrence capability.

The AAR role is a critical enabler for Canadian fighters to conduct long range Arctic missions and potentially intercept Russian bombers prior to their reaching a point where they can launch cruise missiles at our critical infrastructure. AAR is not only a viable solution for Canadian Arctic security but a proven concept to enable a faster reaction to domestic SAR and major disaster scenarios using RW assets. The two examples above using the Cormorant and Chinook in responding to a distress call in the Arctic justify the expansion of the RCAF AAR role to include helicopters. Based on the arguments presented, this chapter clearly demonstrates the crucial role that AAR provides for both fixed wing and rotary wing in the context of Canada's ability to defend its sovereignty and come to the aid of Canadians wherever they reside. The next chapter

¹⁷⁵ As a KC130 pilot with almost 25 years of experience in the field, once aircraft are airborne, the susceptibility of a breakdown is almost nil. Weather can be a factor, but unlike non-AAR missions, the tanker and receiver can modify their course to avoid it.

takes the argument for enhancing RCAF AAR capabilities beyond Canada's borders by showing the essential value in expeditionary operations.

CHAPTER 4: RCAF Expeditionary Operations

Expeditionary operations, as explained by Allan English, are "task-tailored aerospace assets, which are rapidly deployable and able to sustain themselves in operations outside Canadian territory."¹⁷⁶ The concept of expeditionary operations is not new; Canada sent troops to fight overseas as early as the Boer War.¹⁷⁷ The early wars saw Canada amass an army at home to send them abroad for what was often a long, bloody and protracted affair. What has changed in modern expeditionary operations is the manner in which governments use their military in foreign conflicts. The days of amassing an army and kissing them goodbye at the Halifax pier are all but gone with the air force having replaced the army as the primary force for expeditionary operations.

This chapter will focus on the role of AAR during an expeditionary operation, highlighting the intrinsic value of AAR in conducting inter and intra-theatre missions. AAR enables the reach capability for inter-theatre operations while providing the persistence necessary in the theatre of operations.

Expeditionary Doctrine

CF capstone Aerospace Doctrine and CF keystone Move Doctrine's limited insight on AAR in expeditionary operations (see Chapter 2) necessitates the utilization of US doctrine for further amplification on the subject. There are five basic AAR missions outlined in the US Doctrine Joint Publication 3-17 (JP 3-17): global strike support, air

¹⁷⁶ Allan D. English, "Foreword", in *Canadian Expeditionary Air Forces*, Centre for Defence and Security Studies University of Manitoba, (Winnipeg: Contemporary Printing Ltd., 2004), 2.

¹⁷⁷ Canadian War Museum, "Canada and the South African War 1899-1902," last modified [or accessed] 2 April 2015, http://www.warmuseum.ca/cwm/exhibitions/boer/boerwarhistory_e.shtml . The Boer war was fought from 1899-1902, 7000 Canadians were sent overseas, 267 lost their life.

bridge support, aircraft deployment support, theatre support to combat air forces and special operations support.¹⁷⁸ This chapter will validate the RCAF's need for tankers by focusing on three of the basic missions that are directly linked to expeditionary operations: air bridge support, aircraft deployment support and theatre support to combat air forces. The descriptions of the above mentioned missions will substantiate the importance for the RCAF to maintain a robust tanker fleet. First, however, it is necessary to explain the reality in modern expeditionary operations and demonstrate why AAR is an essential enabler of air power.

The Reality of Air Power in Modern Expeditionary Operations

The use of air power in modern conflicts has become the preferred response when diplomacy fails, attributable to the penchant of Western democratic governments favouring a quick response, an even quicker exit and above all, the perceived concept of a "clean war." The perpetuated the notion of a clean war refers to the prolific accuracy of stand-off precision munitions and the expectations of no loss of civilian life: "an antiseptic war where there are no casualties, no harm, and no destruction of consequence."¹⁷⁹¹⁸⁰ In the same context, the use of air power limits the loss of life in democratic Western armed forces, protecting a population whose support for military

¹⁷⁸ Department of Defense, *Joint Publications 3-17 Air Mobility*, 2013(CD-ROM), 100.

¹⁷⁹ M.L.R. Smith, , and Sophie Roberts, " War in the Gray: Exploring the Concept of Dirty War," *Studies in Conflict & Terrorism* 31, no. 5(May 2008),381; last modified [or accessed] April 11 2015, <http://eds.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=c2f58683-e3ea-4506-96c6-99ddac3c80bf%40sessionmgr115&vid=8&hid=127>

¹⁸⁰ Benjamin Lambeth further describes the notion of a clean war: "Pressures to avoid civilian casualties and unintended damage to non-military structures were greater in Allied Force than any previous combat operations." Benjamin S. Lambeth, *NATO's AirWar for Kosovo: A Strategic and Operational Assessment* (RAND, 2001), xvii.

operations may be "casualty averse".¹⁸¹ Casualty aversion is an ever increasing factor when Western democratic governments choose to take part in operations where the population sees a limited national interest.¹⁸² The result of casualty aversion is that air power becomes the safe choice when "governments and citizens naturally prefer low-cost, low-risk operations."¹⁸³ The Canadian government is no exception, aside from its involvement in Afghanistan, Canada's contribution to coalition operations (Gulf War, Kosovo, Libya and Iraq) primarily involved RCAF air power.

The advent of Intelligence Surveillance and Reconnaissance (ISR) platforms on the battlefield (providing the commander with a bird's eye view) has changed the nature of aerial strikes. ISR provides the means to fight a war; preventing unnecessary civilian casualties while targeting the adversary. Known as "dynamic targeting," ISR platforms scrutinize potential adversarial targets to ensure no civilians are present.¹⁸⁴ The target validation process can take time, meaning that strike aircraft have to loiter over the area longer (necessitating more fuel).¹⁸⁵ Real-time video from ISR platforms also allows commanders to re-direct fighters to higher priority targets (again, necessitating more fuel to accomplish the mission). This ever-increasing use of ISR in modern conflicts is evidentiary of the correlation between operations and the need for AAR.

Air bridge support

¹⁸¹ Hugh Smith, "What Costs Will Democracies Bear? A Review of Popular Theories of Casualty Aversion," *Armed Forces & Society* (0095327X) 31, no. 4 (Summer 2005), 489.

¹⁸² *Ibid.*, 507.

¹⁸³ *Ibid.*

¹⁸⁴ Jason M. Brown, "To Bomb or Not to Bomb? Counterinsurgency, Airpower, and Dynamic Targeting." *Air & Space Power Journal* 21, no. 4 (Winter 2007): 82-83., EBSCOhost (accessed April 14, 2015). <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=27872549&site=ehost-live>

¹⁸⁵ Rebecca Grant, *The Tanker Imperative...*, 20.

One of the biggest challenges to any nation participating in expeditionary operations is the logistics involved in moving personnel and equipment to support the campaign. Defined by the JP 3-17, air bridge support using AAR "makes possible accelerated air bridge operations since enroute refueling stops for receivers are reduced or eliminated."¹⁸⁶ Deemed to be an essential requirement for future operations, the conduct of inter-theatre airlift AAR was a lesson the USAF learned in October 1973, during Operation Nickel Grass, where the Egyptian and Syrians launched a military attack on Israel. The US, anxious to come to the aid of Israel, conducted a major airlift operation (Nickel Grass) to provide valuable logistical support. At the time, of all the allied countries, only Portugal allowed the US to land in its territory to conduct the airlift operation (using Lajes Air Base located in the Azores, in the mid-Atlantic ocean).¹⁸⁷ The operation was a success, but one of the lessons learned was that "aerial refueling capability was essential for all inter-theatre airlift forces (only the C-5 Galaxy was AAR capable, the C-141 Starlifter did not have in- refuelling capability)."¹⁸⁸ This lesson was not lost on the USAF, and by the 1980s all C-141s had been modified for in-flight refueling.¹⁸⁹ All USAF inter-theatre airlifters continue with that capability (the C-17 Globemaster III replaced the C-141 in the mid-1990s).

Although the RCAF does not have the capability to conduct air bridge support operations with its current tanker fleet, the CC-177 (RCAF designation for the C-17) is capable of inflight refueling. The comparative advantage for the RCAF to conduct air bridge operations is similar to examples in Chapter 3 (deploying helicopters to the

¹⁸⁶ Department of Defense, *Joint Publications 3-17 Air Mobility*, 2013(CD-ROM), 100.

¹⁸⁷ Keith Hutcheson. *Air Mobility...*, 22-23.

¹⁸⁸ *Ibid.*, 24.

¹⁸⁹ *Ibid.*, 24.

Arctic). Like the helicopters, the same argument can be made of the speed advantage that AAR provides for airlifting vital equipment and personnel into a conflict zone. The table below provides an example of a CC-177 on a resupply mission to the current mission in Kuwait (Operation Impact):

AAR Flight time (@450 knots) ¹⁹⁰ :	Non-AAR- Flight time:
Trenton - Kuwait	Trenton-Frankfurt: 7:41/ 3,348
	Frankfurt-Kuwait: 5:02 /2152
Total time and distance: 12:25/5477nm	Total time and distance: 26:43/5500nm ¹⁹¹

Table 4.1¹⁹²

The table demonstrates the advantage the RCAF could potentially gain were it to have this AAR capability at its disposal. The resupply mission could be completed within a day, possibly allowing for the delivery of critical components much faster than the current situation.

Aircraft deployment support

The JP 3-17 defines aircraft deployment support as: "AAR assets can extend the range of deploying combat and combat support aircraft, allowing them to fly nonstop to an area of operation (AO)."¹⁹³ Along the same vein, aircraft deployment operations can be regarded as the ability to project military power. The United States Marine Corps (USMC) doctrine defines power projection as: "the ability of a nation to apply all or some of its elements of national power...to rapidly and effectively deploy and sustain forces ...

¹⁹⁰ Average cruise speed of a C-17 is 450 knots. US Air Force, C-17 technical data, last accessed [or accessed] April 01 2015, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104523/c-17-globemaster-iii.aspx>

¹⁹¹ The time in this example has aircraft on a stopover in Frankfurt with the added crew rest. If there was an additional crew awaiting the aircraft in Frankfurt, the time would be reduced to approx 15:42. The aircraft would need to be serviced in Frankfurt which normally takes 3 hours.

¹⁹² Flight Manager, last modified [or accessed] April 01 2015, <http://www.flightmanager.com/content/TimeDistanceForm.aspx>

¹⁹³ Department of Defense, *Joint Publications 3-17 Air Mobility*, 2013 (CD-ROM), 100. AOR and JOA were replaced by AO for consistency.

to respond to crises, to contribute to deterrence, and to enhance regional stability."¹⁹⁴ In both cases, the AAR mission is a critical mission enabler, allowing for the rapid movement of the fighter force responding to potential conflict anywhere in the world. For the RCAF, the ability to project power in a timely manner is limited to the number of available tankers and their ability to move fighters (The CC-150T can only ferry four CF-188s at a time across the Atlantic).¹⁹⁵

Regardless of that limitation, it is important to realize that there is a capacity and Canada can respond unilaterally without needing to "rent" AAR support. As Chapter 1 demonstrated, following the retirement of the CC-137 tanker in 1997, the RCAF found itself without a strategic tanker (the CC-130T provides a limited strategic capability). When NATO called on countries to support the Kosovo air war (Operation Allied Force), Canada had to request additional AAR from the USAF to supplement its CC-130T.¹⁹⁶ CF Move Doctrine highlights the intrinsic value of air mobility to which AAR is one of two roles (airlift is the other role): "the backbone of expeditionary operations as it enables the prompt, global application of combat power."¹⁹⁷ OP Mobile, Canada's contribution to OP UNIFIED PROTECTOR, exemplified the immense rapidity that organic AAR can have on RCAF expeditionary operations. Deployed on March 18, 2011, seven CF-188s supported by two CC-150Ts flew from Bagotville to Trapani Italy. On March 21, with the AAR support from the CC-150T, the CF-188s were conducting their first mission.¹⁹⁸ This

¹⁹⁴ United States Marine Corps, "Marine Corps Operations," Marine Corps Doctrinal Publication (MCDP) 1-0, 2011, 56.

¹⁹⁵ RCAF, "CC-150 Polaris: Transport Aircraft," last modified [or accessed] 2 April 2015, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-150.page>

¹⁹⁶ James Fergusson, "Over there from Here: Expeditionary Forces and the Canadian Forces" in *Canadian Expeditionary Air Forces*, Centre for Defence and Security Studies University of Manitoba, ed. by Allan D. English (Winnipeg: Contemporary Printing Ltd., 2004), 49.

¹⁹⁷ Department of National Defence, *Canadian Forces Aerospace Move Doctrine...*, 3.

¹⁹⁸ Joyce, D. BGen, End of Tour Report—Task Force Libeccio, (07 November 2011), 1.

is a remarkable feat for a small air force, a feat that highlights the criticality of having AAR available without having to borrow or rent. The speed of the deployment also highlighted the need for the RCAF to improve their expeditionary support concepts. The result of Op Mobile was the focus towards expeditionary operations (2 Wing Bagotville QC - Air Expeditionary Wing, has greatly enhanced the RCAF's capability to respond to operations quickly) and to demonstrate its commitment to air power, the same effort must now be directed at maintaining an AAR fleet into the future.

The USMC epitomizes what it means to be expeditionary and its doctrinal publication on operations is entirely dedicated to that concept: "the defining characteristic of expeditionary operations is the projection of force into a foreign setting."¹⁹⁹ It is by no surprise that the USMC is dedicated to the AAR role with the acquisition of 79 modern KC-130J, replacing its older C-130T variants.²⁰⁰ The KC-130J provides the versatility to conduct both fighter and helicopter AAR, a necessity for the Marine Corps. The USMC is the expert in the application of expeditionary operations; for the RCAF to be the same solution to the CAF, emphasis must be on the AAR role. Without AAR, Canada loses its own integral capability to swiftly respond to a conflict abroad; and considering that reliance on allied support to move forces is not expeditionary it becomes known as operation "on bended knee."²⁰¹

¹⁹⁹ United States Marine Corps, "Marine Corps Operations," Marine Corps Doctrinal Publication (MCDP) 1-0, 2011, 53.

²⁰⁰ Naval Air Systems Command, "Aircraft and Weapons: C/KC-130 Hercules/Super Hercules", last modified [or accessed] 2 April 2015.
<http://www.navair.navy.mil/index.cfm?fuseaction=home.display&key=96163E6F-65F2-4226-A4FB-B83337AB0C9>

²⁰¹ The Free Dictionary, "on bended knee," last modified [or accessed], 15 April 2015,
<http://idioms.thefreedictionary.com/on+bended+knee> ; the term is an idiom that refers to kneeling, as in supplication. Humbly, pleading.

Theatre support to combat air forces

The JP 3-17 defines theatre support to combat air forces as "intra-theater AR that enables fighter aircraft to increase their range, endurance, and flexibility."²⁰² This is the new standard in modern air warfare; strike operations would be insupportable without AAR.²⁰³ As Rebecca Grant notes, "Decades of taking tankers for granted have obscured the extent to which the tanker force has reshaped the modern air campaign."²⁰⁴ The anonymity of AAR operations within the context of modern air warfare is predominantly due to be the proliferation of airborne ISR assets (such as UAVs) within an AO. In previous conflicts pilots were given a set of targets prior to mission launch, and it would be incumbent on them to make the decision whether or not to drop their weapon, thus limiting the need for AAR. In this new realm of air warfare the pilot's decision to release his/her weapon is often pre-empted by the Combined Air Operations Centre (CAOC), where the "live" feed of the target is identified and validated for civilian casualty potential (the political need for 0 civilian casualties is critical to modern conflicts).²⁰⁵ As a result of the protracted nature of the target engagement authority process and the use of ISR, additional loiter time requirement for strike aircraft necessitates the use of AAR. The increased use of ISR in Afghanistan during Operation Enduring Freedom (OEF) meant that "frequently, fighter and bombers were sent to different areas to await targets or even assigned multiple emerging targets. The only way to provide on-call firepower was with frequent, dependable refueling."²⁰⁶

²⁰² Department of Defense, *Joint Publications 3-17 Air Mobility*, 2013 (CD-ROM), 100.

²⁰³ Rebecca Grant, *The Tanker Imperative...*, 20. In an interview with Gen. Arthur J. Lichte, Commander, Air Mobility Command, he describes that without tankers, the air component commander would need four times the number of fighters to have the same effect.

²⁰⁴ *Ibid.*, 3.

²⁰⁵ *Ibid.*, 20.

²⁰⁶ *Ibid.*, 16.

The targeting assessment process takes time, and time is always limited in terms of fuel available. Without the tanker nearby, the fighter pilot would in most circumstances have a very tight window to conduct his/her mission and potentially be unable to prosecute the target. The final assessment by Rebecca Grant proves that "the result was an expanding concept of expeditionary air warfare that counted more than ever on tankers."²⁰⁷ Commanders in the future will rely even more on the benefits that ISR provides and the only way to mitigate the new realities of air combat is to increase dependence on AAR. The AAR role is a "growth" industry, and unlike Operation Echo in 1999 (Kosovo), the RCAF must continue to commit to the fight with a tanker (i.e., Operation Mobile and Operation Impact).

Support to Fighter aircraft requiring extra loiter time is only one aspect of the mission set. The ability to extend the range of the fighters in an environment where basing is limited is also essential to modern warfare. The number of airfields close to the main effort may not be sufficient to accommodate the number of aircraft required due to geography, security or political circumstances. Under these conditions, where available bases are more distant from the operation, the use of AAR becomes critical: "Improving the range of air-breathing platforms will also delay or prevent compromising one of airpower's greatest advantages: the ability to operate from secure locations outside an adversary's reach."²⁰⁸ In addition to supporting fighters dispersed throughout the AO, AAR enables the principle of concentration of force.²⁰⁹ Moving aircraft from different

²⁰⁷ Ibid., 12.

²⁰⁸ Dr. Panayotis A. Yannakogeorges and Dr. Adam B. Loather. "Saving NATO with Airpower," *The Royal Canadian Air Force Journal*, Vol. 2 No.1 (Winter 2013), 73.

²⁰⁹ Department of National Defence, B-GA-400-000/FP-000, *Canadian Forces Aerospace Doctrine ...*, 24. Concentration of Force: it is essential to concentrate superior force at a time and place.

locations into a single strike package necessitates the use of AAR due to the distance between coalition fighter locations in the AO.

Operations Mobile and Impact

Canada's 1999 participation in Operation Echo (the US led Operation Allied Force) over Kosovo further demonstrated to the RCAF leadership how the lack of a viable strategic AAR asset was detrimental to Canada's ability to independently project power. The USAF provided the CF-188's AAR support to get from Canada to Aviano (CF-188's were based out of Aviano during the Kosovo air war) and once in theatre, the CF-188 relied on coalition refueling to complete its assigned strike missions.²¹⁰ Learning that lesson was instrumental in providing the impetus to modify two CC-150s as tankers: "the deployment and redeployment phases of the operation proved troublesome at best and highlighted the need for the strategic AAR capability."²¹¹ Operation Mobile, the subsequent operation to Operation Echo, was remarkably different with the availability of the CC-150T.

The successful deployment of Op Mobile in 2011 was due to the organic AAR capability that the RCAF has at its disposal. Once in theatre, the RCAF AAR assets continued their amazing contribution to the coalition campaign. Combining the totals of one CC-150T and two CC-130Ts, the RCAF tankers offloaded almost 19 million pounds of fuel and flew 398 missions.²¹² Those remarkable statistics indicate the relevance of

²¹⁰ Danford W. Middlemiss and Denis stairs, *Geopolitical Integrity*, ed. By Hugh Segal (Montreal: The Institute for Research on Public Policy [IRPP], 2005), 165.

²¹¹ Department of National Defence, *AIR FORCE: TOTAL REFUELLING OPERATIONS ENABLING CONCEPT*, V10, 7. The undated draft document was produced by Director Air Strategic Plans 3-2

²¹² Department of National Defence, Joyce, D. BGen, End of Tour Report—Task Force Libeccio, (07 November 2011), 4.

AAR within the RCAF and the importance in coalition operations. For those reasons, Canada must maintain its own integral tanker force.

One current mission is Operation Impact in support of the US led Operation Inherent Resolve (OIR), a multinational coalition intended on degrading and defeating the Islamic State of Iraq and the Levant (ISIL). The Royal Australian Air Force (RAAF) is currently involved in the operation against ISIL and is based out of Al Minhad in the UAE²¹³ whilst the RCAF is also heavily involved in OIR (Operation Impact), basing its air assets in Kuwait.²¹⁴ As previously mentioned, the basing decision often involves a number of issues (political, geography, security etc.) which has for effect of dispersing coalition assets throughout the area. The table below provides a snapshot of the distances required for RAAF and RCAF strike aircraft to reach the AO inside Iraq. The use of Baghdad and Mosul provide some perspective on the distance to potential targets:

Potential target	RAAF F-18 - Al Minhad	RCAF CF-188 - Kuwait
Baghdad	765 nm	320 nm
Mosul	910 nm	500 nm

Table 4.2²¹⁵

Having previously indicated that the average combat radius of an F-18 is approximately 500nm (see Chapter 3), only the CF-188 based out of Kuwait could conduct a strike mission as far as Baghdad. The table is an indicator of the tremendous need for AAR, and the RCAF's contribution of a single CC-150T to the operation has been of remarkable value. To date, the CC-150T has conducted 118 missions and

²¹³ Andrew McLaughlin, "RAAF headed back to Iraq," Australian Aviation, September 14 2014, last modified [or accessed] 2 April 2015 <http://australianaviation.com.au/2014/09/raaf-headed-back-to-iraq/>

²¹⁴ RCAF, "OP Impact", last modified [or accessed] 2 April 2015, <http://www.forces.gc.ca/en/operations-abroad-current/op-impact.page>

²¹⁵ Flight Manager Worldwide, last modified [or accessed] 14 April 2015, <http://www.flightmanager.com/content/TimeDistanceForm.aspx>

offloaded close to 7 million pounds of fuel to CF-188s and other coalition aircraft.²¹⁶ The importance of this contribution must not be underestimated, and although the USAF will continue to provide the preponderance of AAR assets, Canada did not come to the fight empty handed. Failing to provide AAR would be reverting back to 1999 during Operation Echo (Kosovo air war), a step in the wrong direction for the RCAF's ability to contribute effectively to coalition operations.

Conclusion

If the RCAF is to continue to provide forces to support government foreign policy, then AAR is an essential part of that mission set. The very notion of expeditionary operations is intrinsically linked to the ability to project power abroad. Expeditionary operations dictate the requirement for speed, flexibility and reach, all inherent air power characteristics that AAR enables to aircraft carrying out the mission. The three basic AAR roles reviewed in this chapter expound the necessity to have an expeditionary capability using AAR as part of the solution. The RCAF is focused on being that expeditionary force for the government, but the loss of AAR will further diminish that likelihood, and relying on allies or renting AAR is not an appropriate response from a nation that prides itself on supporting international operations such as the current fight against ISIL.²¹⁷

Were the RCAF to outright abandon the AAR role, the rapidity of power projection and its ability to sustain its own forces would disappear; further eroding

²¹⁶ RCAF, "OP Impact", last modified [or accessed] 2 April 2015, <http://www.forces.gc.ca/en/operations-abroad-current/op-impact.page>

²¹⁷ A total of 62 nations are participating in OIR. Global Security.Org, "Operation Inherent Resolve," last modified[or accessed] 2 April 2015, <http://www.globalsecurity.org/military/ops/inherent-resolve.htm>

Canada's international standing with its allies. The pooling of resources is important during coalition operations; however in this case, the independent capability to project air power using AAR is too important to Canada's expeditionary needs. It must be conserved and expanded. The next chapter will outline this requirement.

CHAPTER 5: AIR FORCE OF 2035 - A FOCUS ON THE FUTURE OF AAR

Rebecca Grant in *The Tanker Imperative* asserts that "operational trends over the last forty years have shown that airpower today depends completely on tankers."²¹⁸ With the increasingly important role that AAR plays in operations, the RCAF needs to chart a course in determining the best solution for the future. In 2009, Colonel Michael Dabros, then Commanding Officer of the CFAWC, commented on the Foreword of *Projecting Power: Canada's Air Force 2035* that "Canada's future security challenges will require strategically relevant, operationally responsive and tactically decisive armed forces to defend Canada's interest."²¹⁹ *Air Force Vectors* (AFV), the Air Staff's capstone document, outlines the RCAF Commander's vision of the Air Force: "an agile and integrated air force with the reach and power essential for CAF operations."²²⁰ AAR contributes to the RCAF Commander's vision by providing the essential enabling attributes of reach and power,²²¹ which is congruent with the government's intentions of building "a state-of-the-art military that Canada needs and deserves."²²² The challenge to this vision is the new fiscal restraints under which the CAF finds itself.

²¹⁸ Rebecca Grant, *The Tanker Imperative* ..., 26.

²¹⁹ Department of National Defence, *Projecting Power: Canada's Air Force 2035* (Ottawa: DND Canada, 2009), iv.

²²⁰ Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* ..., 33.

²²¹ Ibid., 39-40. AFV defines "reach" as the ability "to project power in pursuit of national interests across a spectrum of operations and missions," whereas power is described as denying the enemy's ability to control the air by maintaining air superiority.

²²² Department of National Defence, *Canada First Defence Strategy* ..., 3.

The CFDS originally promised a stable and predictable budget to ensure that the CAF could plan ahead and develop into a world class military that is fully capable of responding to the governmental demands²²³; yet the Parliamentary Budget Officer (PBO) released a report in 2015 on the *Fiscal Sustainability of Canada's National Defence Program* which concludes that the recent government cuts to defence spending will have long reaching consequences, making the CFDS unaffordable.²²⁴ According to the PBO's report, the CAF are becoming unsustainable with current allocations²²⁵ as a result of the budget having been stagnated or reduced since 2012. Unless the government reverses the trend in the near future, curtailing acquisition of new platforms (including a new tanker aircraft) will be detrimental to the RCAF's ability to conduct full spectrum operations.

The AAR fleet is critical to the RCAF's vision of reach and power, but budgetary constraints will place enormous pressure on the RCAF to possibly reduce its operational capabilities in order to safeguard others. In light of tight financial resources there are no simple solutions, but eliminating a core role only to satisfy a constrained budget will have a significant negative impact on the RCAF for decades to come. Eliminating the role will also have effects on the government's ability to interject in world events and in turn will diminish Canada's voice internationally. Assuring the viability and efficacy of AAR operations for the future security environment is key to developing an expeditionary RCAF.

²²³Ibid., 5.

²²⁴ Office of the Parliamentary Budget Officer, *Fiscal Sustainability of Canada's National Defence Program*, Ottawa, March 26 2015, 16. Last modified [or accessed], April 4 2015, http://www.pbo-dpb.gc.ca/files/files/Defence_Analysis_EN.pdf

²²⁵ Nowhere near the annual 2% that the CFDS promised in 2008.

Previous chapters have discussed the critical nature of AAR in supporting RCAF missions at home and abroad. Accordingly, this chapter will provide the ideal AAR solution unimpeded by budgetary limitations and offer another solution recognizing the financial restraints. It will provide a recommendation for the most efficient and operationally effective AAR fleet enabling a formidable capability to not only benefit Canadians but also future coalitions.

Future Mission outlook

The Department of National Defence's 2014 report on the *Future Security Environment 2013-2040* recommends that "...the CAF will have to remain able to operate across the whole spectrum of conflict."²²⁶ Remaining capable of meeting the recommendation requires an investment plan that takes into account the future security environment.

The hierarchy of national strategy documents begins with The CFDS. Similar to previous iterations of White Papers on defence, the CFDS's main focus should be to outline the strategic framework and intent set forth by the government to which the CAF are expected to operate. Unfortunately, the CFDS fails to truly achieve its purpose by delving into planned actual specific equipment purchases, thus rendering it as more of an acquisition blueprint rather than a national strategic guidance. Critical of the lack of a true strategy, the 2014 *Strategic Outlook for Canada* from the Canadian Defence Associations Institute (CDAI) states: "the lack of a clear definition of what the Government wants from its armed forces makes it difficult to define a strategy and

²²⁶ Department of National Defence, *the Future Security Environment, 2013-2040* (Winnipeg: 17 Wing Winnipeg Publishing Office, 2014), xiii.

underpin it with the right equipment." ²²⁷ By outlining an acquisition “wish list” without the underlying national strategy, the CFDS removes any latitude for the CAF to define the equipment it needs to meet the government’s expectations. Regardless of the challenges with the CFDS, it identifies six core roles which it expects the CAF to be capable of conducting. These are:

- 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; and
- Deploy forces in response to crises elsewhere in the world for shorter periods. ²²⁸

Each of these roles calls for the employment of RCAF assets combines the need for reach and/or persistence, air power advantages which are attributable to the AAR role. Notably absent from the CFDS re-capitalization plan, however, is an investment in a new AAR fleet ensuring the RCAF’s ability to meet the government’s expectations on delivering the core roles. ²²⁹ It thus becomes obvious that the CFDS falls short on the concept of AAR: “the Strategy will deliver a balanced, multi-role, combat-capable force that will give the Government the necessary flexibility to respond to a full range of

²²⁷ Ferry de Kerckove and Geroge Petrolekas, *The Strategic Outlook for Canada: The Search for Leadership 2014*, Vimy Paper (Ottawa, Canada: Canadian Defence Associations Institute, 2014), 1.

²²⁸ Department of National Defence, *Canada First Defence Strategy...*, 3.

²²⁹ *Ibid.*, 4. These include: 10 to 12 maritime patrol aircraft, 17 fixed-wing search and rescue aircraft and 65 next-generation fighter aircraft.

challenges in the years ahead.”²³⁰ That statement contradicts the reality in which the RCAF will devolve itself of an AAR capability that is instrumental to the delivery of air power. In fact, Colin Gray in *Explorations of Strategy* identifies seven advantages of air power. Of those points, three stand out with respect to AAR: " (1) has a truly global domain, (2) a practically unlimited range and reach, (3) can project power with an unparalleled flexibility for the purpose of achieving what could be a decisive concentration of force.”²³¹ The strategic importance of AAR to the RCAF is essential to the government's ability to project power.

The CFDS needs revision in order to encapsulate a national strategy outlining the government's current and future view on defence. The CDAI in its 2015 *The Strategic Outlook for Canada: The Eclipse of Reason* calls on the next GoC "to undertake a full foreign, trade, development and defence review in order to present a unified vision of Canada's role in the world and of the requirements, globally, to exercise it.”²³² The same paper surmises unless there is a "full rethink" the CAF will face "random and illogical cuts to capability more as a result of rust out than strategy.”²³³ The provision of a new CFDS will allow the RCAF to provide a more profound estimate for future requirements congruent with key government objectives, ensuring that the AAR role is prominent in the future acquisition plans.

The CFDS does provide a blueprint for the acquisition of equipment over the next twenty years, but conspicuously absent from that list is the purchase of new tankers. Removing the inherent advantages of reach and speed that AAR provides reduces the

²³⁰ Ibid., 5.

²³¹ Colin S. Gray, *Exploration in Strategy*..., 72.

²³² Ferry de Kerckove, *The Strategic Outlook for Canada: The Eclipse of Reason 2015*, Vimy Paper (Ottawa, Canada: Canadian Defence Associations Institute, 2015), 41.

²³³ Ibid., 42.

operational effectiveness of the fighter aircraft. The CFDS omission contradicts *Projecting Power: Canada's Air Force 2035*, which states that an "expeditionary air force will be the foundation of military relevance in the year 2035."²³⁴ Chapter 4 clearly outlines that the advantage of having the organic AAR capability was instrumental to the rapid deployment and employment of the CF-188. AFV expects the RCAF to provide "international leadership... this requires the CAF to have the necessary capabilities to make a meaningful contribution across the full spectrum of security challenges."²³⁵ Without AAR, the RCAF will not meet the expectations of the AFV and contribute effectively to the future demands of an environment focused on expeditionary operations.

Regardless of the current CFDS plans, the AAR role continues to become an ever-increasing, essential part of RCAF missions. To highlight this point, the RCAF AFV describes six Enduring Defence Challenges (EDCs) taken from the CDS's vision for the employment concept of the CAF within full spectrum operations. The EDCs listed below provide an overview of those expected to be relevant and responsive now and into the future:

EDC 1 - The RCAF must provide persistent control of the air, across the country, enabled by appropriate surveillance and response capabilities.

EDC 2 - Strategic air mobility will continue to be required for rapid, comprehensive domestic and international response capability.

EDC 3 - Collaboration and interoperability with our allies will remain a key Canadian air power attribute.

EDC 4 - The likelihood of collective actions abroad will require a robust and flexible expeditionary air power capability.

EDC 5 - Our maritime approaches will continue to require the provision of surface and sub-surface air power support, including maritime warning under North American Aerospace Defence Command (NORAD).

²³⁴ Department of National Defence, *Projecting Power: Canada's Air Force 2035* (Ottawa: DND Canada, 2009), 58.

²³⁵ Department of National Defence, *Canada First Defence Strategy* ..., 14.

EDC 6 - The RCAF operations in the Canadian Arctic will grow in importance.²³⁶

The effectiveness of the RCAF hinges on the ability to meet the CDS's vision²³⁷ and deducing the enabling function that AAR plays is critical to meeting the EDCs. Outfitting the RCAF with a capable and relevant AAR fleet becomes more justifiable through evaluating how it enables the mission. The table below these mission details:

EDC	AAR Mission
1	Persistent control of the air cannot be accomplished without the provision of AAR to the fighters patrolling the disputed area. Without tanker support, the need for fighters quadruples (chapter 4) and adds risks to gap coverage (serviceability, weather etc...).
2	AAR is one of two air mobility functions. AAR enables air bridge operations and the ability to rapidly move forces to theatre.
3	Coalition operations always need AAR; a shortage in AAR limits strike capabilities. When Canada contributes AAR (Operation Mobile, Operation Impact), it allows for greater influence within the coalition.
4	AAR provides Canada with the ability to rapidly project power abroad and serves as a deterrence capability.
5	Maritime surveillance could be enhanced with the ability to refuel in-flight. The future replacement of the Aurora and the potential acquisition of UAVs could both be AAR capable. This would provide extended mission maritime surveillance missions.
6	Domestically, the use of AAR enables a more rapid response to SAR and Major Disaster events (Chapter 3). The increasingly contested Arctic will need additional sovereignty flights that can only be

²³⁶ Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* ..., 9.

²³⁷ Commander CJOC does not promulgate an overarching operational directive; rather the Commander will cover off the operational intent on specific operations (i.e., Op Impact). Email from LCol F. Fortin, JFACC LO 2 to CJOC, to author, April 24 2015.

	accomplished with AAR.
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Table 5.1²³⁸

Probe and Drogue vs. Boom

In December 2014, an independent panel tasked by the Canadian government to review the RCAF's future fighter requirements released its latest report. Four companies advocating their fighter aircraft (the Lockheed F35A, the Boeing F/A-18 Super Hornet, the Dassault Aviation Rafale and the Eurofighter Typhoon) participated in the study intent on finding a replacement for the CF-188.²³⁹ Significantly, of the four fighters presented in the report, the F35A (USAF derivative using the boom method of AAR) is the only aircraft incompatible with the RCAF's current AAR fleet (probe and drogue). The original sole-source selection of the F35A was contentious enough, but what has also the ire of critics was the realization that the RCAF's current tanker fleet's method of refueling is strictly the probe and drogue AAR system.²⁴⁰ The option of re-fitting the CC-150T with a boom receptacle is a possibility considering that Airbus used the A310 (same as the RCAF CC-150) as the test bed for the advanced boom now installed on the A330 Multi Role Tanker Transport (MRRT).²⁴¹ Regardless of its retrofit ability, the key issue is that the CC-150T will be a 40 year old aircraft by the time the F35A (if selected) becomes

²³⁸ The mission details contained in Table 5.1 are based on the author's twenty years of AAR experience.

²³⁹ Government of Canada, " Summary Report – Evaluation of Options for the Replacement of the CF-18 Fighter Fleet, December 2014," 20, last modified [or accessed] 6 April 2015, <http://www.tpsgc-pwgsc.gc.ca/app-acq/documents/cf18-eval-eng.pdf>

²⁴⁰ *Maclean's* Magazine, "Canadian Military Unable to Refuel New Jets in Mid-Air," Last modified [or accessed] 6 April 2015, <http://www.macleans.ca/general/canadian-military-unable-to-refuel-new-jets-in-mid-air/>, this is only one example of a number of articles found on the internet making the same statement.

²⁴¹ Jane's online, "A330 MRTT", 5. Last modified [or accessed] April 3 2015, <https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1342559&P ubabbrev=JAWA>

operational in the RCAF. This makes the decision to purchase a modern tanker aircraft rather than modify an existing fleet a better choice.

RCAF Receiver Aircraft

By placing the right focus on the critical role of AAR on the missions in Table 5.1, the number of RCAF aircraft capable of AAR could potentially grow from one (CF-188) to eight or more. The table below outlines the RCAF's current and future aircraft capable of AAR.

Aircraft	Boom	Probe and Drogue
CF-188	No	Yes
Future fighter (4 participants)	Yes (F35A)	Yes, F18 Super Hornet, Rafale, Typhoon,
CC-177	Yes	No
CC-130J	Yes	Yes
FWSAR (C-27J, CASA 295M, C-130J)	Yes (C-130J only)	Yes
CH-149 Cormorant	No	Yes
CH-148 Cyclone	No	Yes
CH-147 Chinook	No	Yes
MPA (CP-140 Aurora replacement) ²⁴²	TBD	TBD

²⁴² Department of National Defence, *Canada First Defence Strategy* ..., 12. The Maritime Patrol Aircraft (MPA) replacement was part of the acquisition list in the 2008 CFDS.

Table 5.2²⁴³

As Table 5.2 shows, AAR should not be limited to fighter operations. Modifying the receiver aircraft to improve AAR capability in the RCAF comes with some technical challenges but is not insurmountable.²⁴⁴

Tankers

Versatility and multi-role capability are two essential requirements for the future tanker fleet.²⁴⁵ As directed by AFV: "the Air Force will continue to pursue the operational advantages and cost efficiencies afforded by multi-role platforms, crews, and weapons."²⁴⁶ An example of a multi role capability already in operation is the KC-135's Roll On Beyond-Line-of-Sight Enhancement (ROBE) communication system. Produced by Northrup Grumman, it virtually transforms the KC-135 tanker into a command and control (C2) aircraft.²⁴⁷ The ability for the tanker to act as a C2 platform (with ROBE installed, the tanker is now a multi-mission platform) provides substantial advantage to Canada, especially in the Arctic, where communications are limited due to technical challenges (which are beyond the scope of this paper) and a lack of ground communication infrastructure.²⁴⁸

The large tanker competitors, the Boeing KC-46A (Figure 5.1) and the Airbus

²⁴³ Jane's Online, last modified [or accessed] April 3 2015, <https://janes.ihs.com> , all aircraft data were derived from Jane's online.

²⁴⁴ Jane's Online, last modified [or accessed] April 3 2015, <https://janes.ihs.com> , manufactures have either demonstrated this capability or it is currently operational.

²⁴⁵ Jane's Online, last modified [or accessed] April 3 2015, <https://janes.ihs.com> , all aircraft data were derived from Jane's online.

²⁴⁶ Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* ..., 41.

²⁴⁷ Northrup Grumman, " Roll-On Beyond Line-of-Sight Enhancement (ROBE), last modified [or accessed] 6 April 2015, http://www.northropgrumman.com/Capabilities/ROBE/Documents/ROBE_factsheet.pdf

²⁴⁸ Arctic Communication Infrastructure Assessment Report, last modified [or accessed] 7 April 2015, <http://www.aciareport.ca/>, further information is available describing the technical challenges with Arctic communications.

A330 MRTT (Figure 5.2), are based on commercial aircraft designs. Both are capable of having either the probe and drogue or the boom refueling methods installed, thus providing flexibility during coalition operations. Moreover, they are also capable of carrying equipment and conducting refuelling simultaneously. Each of these aircraft can act as a communication relay platform, a must for Canadian operations in the north. The A330 MRTT has found a number of international customers: the RAF, RAAF, the French Air Force, the Saudi Air Force, and Singapore. The Japanese and Italian Air Forces are operating the KC-767 while the USAF has selected their replacement tanker to be the KC-46A variant, based on the cargo version of the 767 aircraft. What sets the two aircraft apart is the size of the aircraft: the A330 is more than 30 feet longer and can carry more fuel and/or freight.²⁴⁹ The Request for Proposal providing the information necessary to assess the two competitors will determine a more comprehensive method of evaluation in the future. However, based on the need to stay interoperable with Canada's closest ally, the RCAF should select the KC-46A.

²⁴⁹ Jane's Online, last modified [or accessed] April 3 2015, <https://janes.ihs.com>.

Figure 5.1, KC-46A²⁵⁰Figure 5.2, A330 MRTT²⁵¹

As the Chapter 3 scenarios prove, the ability to refuel helicopters in Canada would aid in improving the response time for SAR and/or major disasters in the Arctic or elsewhere in Canada. Due to speed constraints, the A330 and KC-46A tankers cannot refuel helicopters and thus there is a requirement to consider smaller tactical tankers. The two current aircraft available to conduct that mission are the A400M (Figure 5.3) and the KC-130J (Figure 5.4). The A400M is a larger, 4 engine turbo-prop aircraft capable of similar missions as the CC-130J. Size aside, the major difference between the two is that

²⁵⁰US Air Force, "Boeing KC-46A Pegasus," last modified [or accessed] 25 April 2015, <http://www.af.mil/News/Photos/tabid/129/igphoto/2000261166/Default.aspx>

²⁵¹ Airbus Military, "A330 MRTT" last modified [or accessed] 15 April 2015, <http://militaryaircraft-airbusds.com/Aircraft/A330MRTT/A330MRTTAbout.aspx#content02>

the KC-130J is an operationally proven platform (Canada already flies the CC-130J, which could leverage training and maintenance already in place), whereas the A400M is still undergoing initial operational capabilities development. The selection of a probe equipped fighter would make the A400M a contender due to its greater flexibility than a KC-130J. The A400M would be able to fill the role of both strategic and tactical tankers, reducing the number of platforms to one, providing for long-term efficiencies in terms of training and logistics. It is a multi-role aircraft able to air refuel fixed-wing and helicopter assets and (as a cargo aircraft) capable of carrying outsized equipment.²⁵² The A400M's only drawback is its inability to refuel the CC-177 aircraft, thus the RCAF would be unable to support the air bridge mission (see Chapter 4).



Figure 5.3, A400M²⁵³



Figure 5.4, KC-130J²⁵⁴

²⁵² Jane's online, "Airbus A400M Atlas", last modified [or accessed] 3 April 2015, <https://janes.ihs.com/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1342558&PUBABBREV=JAWA>, Airbus has only demonstrated the AAR capability but expects the aircraft to be operational in the AAR role by 2017.

²⁵³ Airbus Military, "A400M," last modified [or accessed] 15 April 2015, <http://militaryaircraft-airbusds.com/Aircraft/A400M/A400MAbout.aspx#content02>

A final look at the potential tanker fleet is challenging due to the large mission variances based on the AFV's EDCs. In order to narrow the recommendation, this chapter examines a scenario where the RCAF is engaged in an expeditionary mission (such as Operation Impact), must maintain the NORAD tanker role (currently provided by the USAF), all whilst maintaining a capability to support a SAR mission (the major disaster mission will also be incorporated). According to the Aerospace Capability Framework (ACF), a reasonable expectation is that seventy percent of the fleet will be serviceable and that the Mission Ready (MR) rate is fifty percent.²⁵⁵ Under an ideal set of circumstances, the RCAF would be requesting a tanker fleet that permits the fulfillment of the complete AAR solution: both fixed wing and rotary wing. As previously indicated, AAR is the only solution enabling the conduct of modern air warfare operations and Table 5.3²⁵⁶ reflects this philosophy:

Tanker	Expeditionary	NORAD	Domestic SAR
KC-46A	1	2	0
KC-130J	0	0	2
Total MR Force @ 50%	2	4	4

Table 5.3

The total numbers indicate that the RCAF needs a minimum fleet of 6 KC-46A and 4 KC-130J tankers. The combination of these two tanker aircraft ensures that the RCAF is an "instrument of Canada's national power...able to deploy globally, often in unstable areas to contribute to the Government's foreign policy and national security

²⁵⁴ Lockheed Martin, "KC-130J Tanker," last modified [or accessed] 15 April 2015, <http://www.lockheedmartin.com/us/products/c130/c-130j-variants/kc-130j.html>

²⁵⁵ Department of National Defence, *The Aerospace Capability Framework* (Ottawa: Director General air Force development, 2003), 21.

²⁵⁶ The table reflects the mission concept where 2 tankers are holding a permanent standby posture supporting NORAD and SAR (1 in the West and 1 in the East of the country) and 1 tanker is on expeditionary ops.

objectives in order to defend Canada and Canada's interests."²⁵⁷ Under the auspices of budgetary constraints, both aircraft must be a multi-role platform. The KC-46A's ability to transport both personnel and cargo substantially increases an already capable and versatile air mobility fleet. Employing the KC-130J in the SAR role is a possibility. Depending on the results of the Fixed Wing Search and Rescue (FWSAR) competition, and if Lockheed were to win the contract (C-130J) those aircraft could be outfitted with AAR pods,²⁵⁸ thus eliminating the need for a separate tactical AAR fleet all together.

The perception that AAR is merely a support capability and not intrinsically linked to success in operations ignores the reality of a rapid deployment like Operation Mobile or the current Operation Impact mission.²⁵⁹ The rapid deployment of the CF-188s to Trapani Italy and the deployment to Kuwait encapsulate the statement found in the AFV: "The need to deploy rapidly with a robust force and for a sustained period both at home and abroad places a premium on global mobility and expeditionary capabilities, defined by reach, speed, agility, lethality, and combat readiness."²⁶⁰ Simply put, there is no expeditionary capability without AAR: it is an essential part of RCAF expeditionary operations and not simply a "desirable" option.

Maintaining a limited AAR role

Realizing that the ideal course of action may not fit with the financial resources available, the minimum intent would be to maintain a semblance of AAR capability within the RCAF. The lowest cost option truly depends on the aircraft selected to replace

²⁵⁷ Department of National Defence, *The Future Security Environment, 2013-2040* ..., 3.

²⁵⁸ Our current fleet of CC-130T is dual-roled, supporting tanking operations and conducting SAR.

²⁵⁹ See Chapter 4.

²⁶⁰ Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* ..., 23.

the CF-188, given that the preponderance of mission necessitating AAR still rests with the fighter force. As Chapters 3 and 4 demonstrate, the ability of reach and power rests entirely with the combination of a fighter and tanker enforcing Canadian sovereignty and/or national interests globally through kinetic means. This limited AAR option looks very much like the Director of Air Readiness draft project, recommending the replacement of the CC-150T with two modern aircraft of similar size and capability.²⁶¹ The draft project allows for some expeditionary capability, but is insufficient in fully meeting Canada's AAR requirements. The need would still exist to "borrow or rent" AAR from the USAF to support the deployment of fighters overseas and conduct sovereignty operations. AFV states conclusively that the notion of reach and power without AAR would be difficult to achieve: "without the coercive ability to control and shape the environment when, where, and how we desire, CAF air power will have limited value."²⁶² As the AFV indicates, a total fleet of only two aircraft would leave the RCAF with one mission capable tanker (50% MR) placing Canada's ability to defend its northern border in the hands of the USAF. This limited acquisition measure would not provide any capability to enable national sovereignty operations (or support to NORAD) or expand the role to support SAR in the Arctic. What this proposed replacement option does is maintain the current fleet status, thereby providing the RCAF with a very limited global power projection.

²⁶¹ Department of National Defence, "Multirole Tanker Transport Replacement Project," Project File No. C. TBD Version 1, 15 Jan 2012, 1.

²⁶² Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors...*, 22.

The commercial option

When KPMG²⁶³ indicated that the CAF would look to commercial AAR or borrow from allies, it became evident that DND did not fully explore the commercial AAR market.²⁶⁴ There exists only one commercial operator capable of providing AAR: Omega Air Refueling Services currently operates a fleet of two Boeing 707 tankers and 1 KDC-10, mainly supporting US Navy and USMC aircraft.²⁶⁵ Presently only capable of probe and drogue operations, Omega is therefore not a viable option for the potential F35A acquisition, nor does it provide a long term solution for the RCAF's AAR requirements. The draft project on the strategic tanker replacement from the Director of Aerospace Readiness (DAR) made the assertion in 2012 (prior to the release of the KPMG report) when it concluded that "the availability of commercial assets in the long term is unknown, and there is no guarantee that charter or allied forces aircraft will be available when required to meet the CF's urgent AAR needs."²⁶⁶ In light of those details, relying on commercial AAR or allies is not a long term option for the RCAF's expeditionary mindset.

The entire AAR replacement plan hinges on the acquisition of the next generation fighter aircraft. If the selected aircraft replacing the CF-188 is probed equipped, then the potential for a more deliberately planned acquisition of replacement aircraft exists (the

²⁶³ KPMG, last modified [or accessed], 15 April 2015, <http://www.kpmg.com/ca/en/about/organization/pages/default.aspx>; KPMG is a Canadian leader in delivering Audit, Tax, and Advisory services.

²⁶⁴ KPMG, *Next Generation Fighter Capability: Independent Review of Life Cycle Cost* (Ottawa, 27 Nov 2012): 21; <https://www.tbs-sct.gc.ca/reports-rapports/ngfc-cng/irlc-eiccv/irlc-eiccv-eng.pdf>; Internet; accessed 8 February 2015.

²⁶⁵ Omega Air Refueling Services, last modified [or accessed], 7 April 2015, <http://www.omegairrefueling.com/vms/>, Omega does indicate that it has previously supported RCAF CF-188s in training missions.

²⁶⁶ Department of National Defence, "Multirole Tanker Transport Replacement Project," Project File No. C. TBD Version 1, 15 Jan 2012, 3.

CC-150T and CC-130T could stay in service beyond 2025). However, until the government awards a contract to replace the CF-188 (providing clarification and direction for AAR), the RCAF must continue to operate the CC-130T and not allow for the disposal of the aircraft when the new FWSAR replacement arrives (the CC-130T is linked to the retirement of the CC-130H fleet as part of the FWSAR program).²⁶⁷

Conclusion

This chapter's focus of developing a strategy for the future acquisition of a modern, multi-purpose tanker fleet includes numerous reports and documents pointing to the criticality of AAR in the RCAF both domestically and internationally. The AFV concludes with "irrespective of the frequency, international commitments will require a rapid response, underpinning the need to maintain robust expeditionary capabilities."²⁶⁸ The above recommendation provides the most complete AAR option and enables the projection of power in accordance with the current and future RCAF missions. The sheer size of Canada demands the RCAF be able to respond in a timely manner, with air refuelling as the only enabling solution. With a large number of acquisition options still to be evaluated, it is not within the scope of this study to uncover all the permutations; rather the intention was to provide a "what if" look at the capabilities of a modern AAR fleet supporting air operations.

The chapter outlines a clear path for a "way ahead" concerning the AAR role, outlining the fundamental criteria for a robust modern fleet that will support RCAF air power. It is evident that the future of air power includes AAR, and if the RCAF is going

²⁶⁷ Government of Canada, "Fixed-Wing Search and Rescue (FWSAR) Aircraft Project," last modified [or accessed], 7 April 2015, <http://www.tpsgc-pwgsc.gc.ca/app-acq/stamgp-lamsmp/svtvn-rscfw-eng.html>

²⁶⁸ Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors* ..., 23.

to stay relevant domestically and internationally AAR is not only desirable but essential.

CONCLUSION

Nothing from combat forces to humanitarian aid moves quickly and decisively without air mobility.

—General Henry Shelton, Chairman of the Joint Chiefs of Staff, August 1999

Since the release of the 2008 Canada First Defence Strategy, the focus of the government for the RCAF has been squarely on the acquisition of a replacement fighter aircraft for the venerable CF-188. However, the arguments for and against a number of competitors have clouded some of the overarching challenges that the RCAF will face in the 20 year horizon of the CFDS. In particular, the recapitalization of the present tanker fleet was omitted from the CFDS. As this study has shown, Air-to-Air Refueling in the form of a capable tanker fleet represents the most efficient means to move aircraft both domestically and internationally. Support to national sovereignty, SAR and the concept of an expeditionary air force must include a robust fleet of tankers—the ultimate force multiplier.

From the inception of military flying operations, the need to increase speed and range has always been the ultimate target for aircraft designers. Chapter 1 highlighted the development of AAR starting with the first flight in 1923; the goal was to develop the AAR role into a true military mission. Pioneers such as Carl Spaatz flying the Question Mark set an endurance record in 1929, staying airborne for 150 hour in an attempt to prove the concept of AAR. Sir Alan Cobham continuously looked for improvements in the AAR concept, to make it safer and more efficient, eventually developing a system that is still in use today: the probe and drogue.

Chapter 2 provided the background that the implementation of AAR was not a coincidence, as air power theorists Douhet, Trenchard and Mitchell theorized on the ability of the aircraft to strike deep into enemy territory with the goal of demoralizing the civilian population. Nowadays, the provision of AAR gives strike aircraft unlimited range to attack targets anywhere. The works of the early theorists (along with Clausewitz's principles of warfare) have helped forge western air power doctrine. Their theories developed in the early days of aviation form the basic concepts found in the *Canadian Forces Aerospace Doctrine*. The CF Aerospace Doctrine emphasizes a number of air power characteristics (reach and speed) and tenets (flexibility, versatility, persistence and concentration) linked to those early concepts and in turn validating the intrinsic value that AAR provides in today's modern air force.

Chapter 3 focused the need for AAR in the context of national sovereignty. First elected in 2006, Prime Minister Harper led Canadians to focus northward and understand the realities that the Arctic poses to Canadian sovereignty. Coining the famous line "use it or lose it,"²⁶⁹ Prime Minister Harper insisted that the CAF be capable of operating in Canada's North, leading to the development of a number of Arctic exercises (Operation Nanook being the largest yearly Arctic exercise) to showcase and develop capabilities allowing for improved responses to the needs in this part of the country. Along with the Canadian Rangers, the RCAF is a leader in its ability to provide a year-round Arctic presence. But notably absent in the Arctic conversation is the expansion of AAR to provide a more rapid response to events in this region.

²⁶⁹ Prime Minister Harper, "Prime Minister Harper Announces New Offshore Patrol Ships," last modified [or accessed], 7 April 2015, <http://www.pm.gc.ca/eng/news/2007/07/09/prime-minister-stephen-harper-announces-new-arctic-offshore-patrol-ships>

Climate change poses another challenge to Arctic sovereignty; the reduced ice coverage will provide the backdrop for increased oil and gas exploration, shipping and tourism. The negative aspect to this change will be the increased potential for sovereignty challenges inside Canada's declared EEZ, smuggling and major disasters will also increase. All these likely situations create a need for the RCAF to respond rapidly by providing assistance to OGDs and/or enforcing Canada's sovereignty over its territorial boundaries. AAR is the one enabler that covers the full spectrum of RCAF's future responses. AAR can provide the necessary fuel required for SAR aircraft to fly non-stop; and it can also provide the reach necessary for fighter aircraft to intercept airborne intruders. In addition, tankers can permit fighter aircraft to loiter longer, allowing for persistence of presence otherwise unable to accomplish without AAR. Adding a number of potential receivers would only enhance what could be an exceptional capability in the provision of AAR for the full spectrum of missions in accordance with the AFV.

In line with Arctic sovereignty is the re-emergence of Russia as a provocateur, developing its military presence in the Arctic, ensuring its ability to confront future events that may pose a threat to its perceived sphere of influence. Canada has an inherent need to be able to deter that threat and not simply rely on the US to provide the means to deter. NORAD is a partnership and Canada needs to show the US that it too is serious about defence. Purchasing tankers to support its own fighters attached to NORAD is a start. The US currently has a very old tanker fleet; recapitalizing the 50 year old KC-135 will be expensive and drawn out, and it is quite plausible that the US will expect Canada to "ante up" in order to provide for its own defence and correspondingly carry out its bilateral responsibilities for the defence of North America.

Chapter 4 took a look at International events which often require rapid deployment of forces to deter or defeat the rising threat. As Operations Mobile and Impact have convincingly demonstrated, the ability to move fighters to the conflict zone in the shortest possible time is essential to the early success of operations. The use of AAR during both operations was the critical linchpin to the entire movement of the CF-188s; without the enabling capability that organic RCAF provides, Canada would need to borrow or rent tankers, potentially delaying their arrival. The government has made it clear that it expects the RCAF to be capable of responding quickly and nothing is quicker than air power enabled by tankers.

More often, Western politicians concerned with the population's casualty aversion during military interventions will call upon the Air Force to intervene. Air power has become the response force for Western governments who still need to show international presence but want to limit inflicting casualties to its own military. Canada has shown a similar pattern over the past twenty years and the future points to a continuation of interventions by the RCAF. The maintenance of the AAR role will be crucial to providing the reach and speed necessary for those future crises requiring air power.

Another aspect of modern warfare that points to the increasing need for AAR is the political desire to fight a "clean war." The expectation tied to this desire has placed enormous pressure on commanders to eliminate civilian collateral damage from air strikes. The second order effect of this political necessity has made the targeting process protracted: commanders insist on having direct input on the decision making process during the strike mission. The culminating result has made AAR essential due to the strike aircraft's increased loiter time over potential targets. The selection of a staging location, whether political or geographical, poses additional target-reach constraints in the

AO, making AAR essential for coalition air power. As Canada prepares to re-invest in its fighter fleet, it must also recognize the significance of AAR within an expeditionary construct. Ignoring the significance of AAR will only limit the RCAF's expeditionary capabilities; reliance on allies and commercial refueling service providers should never be the primary course of action.

The only certainty is that the future is uncertain, and if the RCAF is ill-equipped to face those eventual uncertainties then air power will have limited means to protect Canadian interests at home and abroad. Chapter 5 looked at the potential future of the RCAF and the inherent capability that AAR offers. The Canadian people deserve a RCAF capable of rapidly responding to a multitude of events threatening Canadian interests. Whether saving lives or supporting coalition operations, the RCAF must be able to react independently without the need to beg for support from Canada's allies. The overarching issue is not whether the future fighter is compatible with the existing tanker fleet. The challenge facing the RCAF's Commander's vision is convincing the government to re-invest in a modern world class tanker fleet regardless of the future fighter acquisition. Clearly articulating the critical nature of a robust Air-to-Air Refueling fleet capable of more than a token expeditionary mission will take on more importance when facing budgetary limitations. The government promises a first-class military and that military needs an RCAF capable of independent power projection that only Air-to-Air refueling can provide. This paper clearly demonstrates the decisive role that Air-to-Air Refueling plays in RCAF operations; it is a "growth industry" and for the RCAF to stay relevant in its ability to command the air, the time has come to re-invest in Air-to-Air Refueling.

BIBLIOGRAPHY

- Bender, Jeremy. "This map shows the massive scale of Russia's planned fortification of the Arctic", *Business Insider*, March 17 2015, last modified [or accessed] 25 March 2015. <http://www.businessinsider.com/chart-of-russias-fortification-of-the-arctic-2015-3>
- Bolkom, Christopher. "Air Force Aerial Refueling, Congressional Research Service Report for Congress." Foreign Affairs, Defence, and Trade Division, September 19, 2005; <http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=19114054&site=ehost-live>; Internet; accessed 8 December 2014.
- Bolkom, Christopher and Knight, William. "Air Force Air Refueling: The KC-X Aircraft Acquisition Program: RL34398." Congressional Research Service: Report, Foreign Affairs, Defence, and Trade Division, February 2008; <http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=31215582&site=ehost-live>; Internet; accessed 8 December 2014.
- Brosnan, Ian G., M. Leshine and Edward L. "Cooperation or Conflict in a Changing Arctic? Opportunities for Maritime cooperation in Arctic National Strategies,' in *The Fast Changing Arctic: Rethinking Arctic Security for a Warmer World*, ed. Barry Scott Zellen, 83-102. Calgary: University of Calgary Press, 2013.
- Brown, Jason M. "To Bomb or Not to Bomb? Counterinsurgency, Airpower, and Dynamic Targeting." *Air & Space Power Journal* 21, no. 4 (Winter 2007): 75-85. EBSCOhost (accessed April 14, 2015). <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=27872549&site=ehost-live>
- Canada. Department of National Defence. 1 Canadian Air Division Orders, RCAF Flight Operations Manual, effective 21, March 2015, Annex 2.3.3.2.
- Canada. Department of National Defence. AIR FORCE: TOTAL REFUELLING OPERATIONS ENABLING CONCEPT, V10
- Canada. Department of National Defence, A-GA-007-000/AF-008 *Air Force Vectors*. Ottawa: DND Canada, 2014.
- Canada. Department of National Defence. Chief of the Air Staff. *Commander Air Command Annual Planning Directive*, June 30 2011.
- Canada. Department of National Defence. *Canadian Forces Aerospace MOVE Doctrine*, B-GA-404-000/FP-001. Trenton: Canadian Forces Air Warfare Centre, November 2011.

- Canada. Department of National Defence. *Canadian Forces Aerospace SHAPE Doctrine*, B-GA-403-000/FP-001. Trenton: Canadian Forces Air Warfare Centre, March 2014.
- Canada. Department of National Defence. *The Aerospace Capability Framework*. Ottawa: Director General air Force development, 2003.
- Canada. Department of National Defence. *Projecting Power: Canada's Air Force 2035*. Ottawa: DND Canada, 2009.
- Canada. Department of National Defence. *Canada First Defence Strategy*. Ottawa: Canada Communication Group, 2008.
- Canada. Department of National Defence. *The Future Security Environment, 2013-2040*. Winnipeg: 17 Wing Winnipeg Publishing Office, 2014.
- Canada. Department of National Defence. "Multitrole Tanker Transport Replacement Project." Project File No. C. TBD Version 1, 15 Jan 2012.
- Canada. Department of National Defence. *1964 Defence White Paper*. Ottawa: Canada communications Group, 1964.
- Canada. Department of National Defence. *1970 Defence White Paper*. Ottawa: Canada communications Group, 1964.
- Canada. Department of National Defence. Joyce, D. BGen. End of Tour Report—Task Force Libeccio, (07 November 2011)
- Canada. Office of the Parliamentary Budget Officer. *Fiscal Sustainability of Canada's National Defence Program*. Ottawa, March 26 2015. Last modified [or accessed], April 4 2015. http://www.pbo-dpb.gc.ca/files/files/Defence_Analysis_EN.pdf
- Canada. Government of Canada. Arctic Communication Infrastructure Assessment Report, last modified [or accessed] 7 April 2015, <http://www.aciareport.ca/>
- Canada. Government of Canada. *Report of the Auditor General of Canada to the House of Commons Chapter 2: Replacing Canada's Fighter Jets*. Ottawa, spring 2012. Last modified [or accessed] 14 February 2015; http://www.oag-bvg.gc.ca/internet/docs/parl_oag_201204_02_e.pdf
- Canada. Government of Canada. "Fixed-Wing Search and Rescue (FWSAR) Aircraft Project," last modified [or accessed], 7 April 2015, <http://www.tpsgc-pwpsc.gc.ca/app-acq/stamgp-lamsmp/svtvn-rscfw-eng.html>
- Canada. Government of Canada. "Summary Report – Evaluation of Options for the Replacement of the CF-18 Fighter Fleet, December 2014." Last modified [or

accessed] 6 April 2015, <http://www.tpsgc-pwgsc.gc.ca/app-acq/documents/cf18-eval-eng.pdf>

- Canada. Government of Canada. *Canada's Northern Strategy: Our North, Our Heritage, Our Future*. Ottawa: Minister of Public Works and Government Services Canada, 2009.
- Canada. Government of Canada, Standing Senate Committee on National Security and Defence, *Sovereignty and Security in Canada's Arctic: Interim Report*" March 2011.
- Canada. Department of National Defence. *Canada Command CONPLAN 10250/10 MAJAID – CF Response to a Major Air Disaster*. Ottawa: Commander Canada Command, 2010.
- Canadian War Museum, "Canada and the South African War 1899-1902," last modified [or accessed] 2 April 2015, http://www.warmuseum.ca/cwm/exhibitions/boer/boerwarhistory_e.shtml
- Centre for Defence and Security Studies University of Manitoba. Edited by English, Allan D. *Canadian Expeditionary Air Forces*. Winnipeg: Contemporary Printing Ltd., 2004.
- Centre for Defence and Security Studies University of Manitoba. Edited by Huebert, Rob. *Thawing Ice – Cold War: Canada's Security, Sovereignty, and Environmental Concerns in the Arctic*. Winnipeg: Contemporary Printing Ltd., 2009.
- Centre for Defence and Security Studies University of Manitoba. Edited by English Allan D. *Air Campaigns in the New World Order*. Winnipeg: Contemporary Printing Ltd., 2005.
- Charters, David. 2004. "Defence Against Help: Canadian-American Cooperation in the War on Terrorism." *Conference Papers -- International Studies Association* 1-17., EBSCOhost (accessed April 10, 2015). <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=16050608&site=ehost-live>
- Christie, Carl A. "Our First NATO Wing: No. 1 Fighter Wing, RCAF Station North Luffenham, Rutland, England, 1951-1955." Historical Conference Paper, 2004.
- Clausewitz, Carl von. *On War*. Edited and translated by Michael Howard and Peter Paret. Princeton: Princeton University Press, 1976

- Coates, Ken S., P Whitney Lackenbauer, William R. Morrisson and Greg Poelzer. *Arctic Front: Defending Canada in the Far North*. Toronto: Thomas Allen Publishers, 2008.
- Cohen, Major David M. "The Vital Link: The Tanker's Role in Winning America's Wars." Air University Fairchild Papers. Air University Press Maxwell Air Force Base, Alabama, March 2001.
- Danford W. Middlemiss and Denis stairs. *Geopolitical Integrity*. Edited by Hugh Segal. Montreal: The Institute for Research on Public Policy, 2005.
- Dee, Squadron Leader A.G.O. "Air-to-Air refueling in the Canadian Forces until 2010" Toronto: Canadian Forces College Command and Staff Course Exercise Bright Light, 1988.
- de Kerckove, Ferry and Geroge Petrolekas. *The Strategic Outlook for Canada: The Search for Leadership 2014*. Vimy Paper. Ottawa, Canada: Canadian Defence Associations Institute, 2014.
- de Kerckove, Ferry. *The Strategic Outlook for Canada: The Eclipse of Reason 2015*. Vimy Paper. Ottawa, Canada: Canadian Defence Associations Institute, 2015.
- Dougherty, Lieutenant Colonel, Stanley J. "Air Refueling: The Cornerstone of Global Reach – Global Power." Academic Paper. Air war College Air University, Maxwell Air Force Base, Alabama, April 1996.
- Douhet, Giulio. *The Command of the Air*. Translated by Dino Ferrari. New York: Coward-McCann, 1942.
- Gorenburg, Dmitry. "Russia in the Arctic." *Russian Politics & Law.*, Vol. 50 Issue 2, (Mar/Apr2012): 3-6;
<http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=74132269&site=ehost-live>; Internet; accessed 15 Dec 2014.
- Gorenburg, Dmitry. "Russia in the Arctic." *Russian Politics & Law.*, Vol. 50 Issue 2, (Mar/Apr2012): 3-6;
<http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=74132269&site=ehost-live>; Internet; accessed 16 Dec 2014.
- Grant, Rebecca. *The Tanker Imperative*. Mitchell Institute for Air power Studies. Mitchell Institute Press, 2009.
- Gray, Colin S. *Explorations in Strategy*. Westport CT. Praeger Publishers, 1998.

- Hensel, Nayantara. "Globalization and the U.S. Defense Industrial Base: the Competition for a New Aerial Refueling Tanker." *Business Economics*, Vol. 43 Issue 4, (Oct 2008): 45-56;
<http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=36154440&site=ehost-live>; Internet; accessed 8 December 2014.
- The Heritage Foundation. Edited by Dakota L. Wood, "2015 Index of US Military Strength; Assessing America's Ability to Provide for the Common Defense," 31, last modified [or accessed] 29 March 2015, http://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf
- Holder, Bill and Mike Wallace. *Range Unlimited: A History of Aerial Refueling*. Atglen, PA: Shiffer Publishing Ltd., 2000.
- Home, Major T.A. "Aerospace Requirements for Arctic Sovereignty and Security." Toronto: Canadian Forces College Masters in Defence Studies Research Project, JCSP 34.
- Hutcheson, Keith. *Air Mobility: The Evolution of Global Reach*. Beltsville MA: Todd Allan Printing, 1999.
- Jackson, Aaron P. "The Emergence of a Doctrinal Culture within the Canadian Air Force." *The Canadian Air Force Journal* Vol 2. No.3 (Summer 2009): 39-45
- Jane's Online. Last modified [or accessed] April 3 2015, <https://janes.ihs.com>
- Joint Air Power Competence Centre. "Air-to-Air Refuelling Consolidation - An Update," Joint Air Power Competence Centre publication, March 2014.
- Killingsworth, Paul S. "Multipoint Aerial Refueling: A Review and Assessment." RAND National Defense Research Institute, Contract DASW01-95-C-0059, 1996.
- Le Miere, Chirstian and Jeffrey Mazo. *Arctic Opening: Insecurity and Opportunity*. New York: Routledge 2013.
- Maclean's Magazine. "Canadian Military Unable to Refuel New Jets in Mid-Air," Last modified [or accessed] 6 April 2015, <http://www.macleans.ca/general/canadian-military-unable-to-refuel-new-jets-in-mid-air/>
- McDorman, Ted L. "Canada's Ocean Jurisdiction in the Arctic: An overview of Maritime Boundary Issues," in *Thawing Ice -- Cold War: Canada's Security, Sovereignty, and Environmental Concerns in the Arctic*. Edited by Rob Huebert, 11. Winnipeg: Centre for Defence and Securities Studies, 2009.
- McLaughlin, Andrew. "RAAF headed back to Iraq," *Australian Aviation*, September 14 2014. Last modified [or accessed] 2 April 2015
<http://australianaviation.com.au/2014/09/raaf-headed-back-to-iraq/>

- Meilinger, Phillip S. *Airwar: Theory and Practice*. Portland, OR: FRANK CASS Publishers, 2003
- Milberry, Larry. *Sixty Years: The RCAF and CF Air Command 1924-1984*. Toronto: Bryant Press Limited, 1984.
- Milberry, Larry. *Air Transport in Canada*. Toronto: CANAV Books, 1997.
- Organ, R., R Page, D. Watson and L. Wilkinson. *Avro Arrow*. Erin, ON: The Boston Mills Press, 1980.
- Dr. Panayotis A. Yannakogeorges and Dr. Adam B. Loather. "Saving NATO with Airpower," *The Royal Canadian Air Force Journal*, Vol. 2 No.1 (Winter 2013): 67-77.
- Poitras, Dany. "Search and Rescue in the Arctic: A Myth or Reality." Masters in Defence Studies, Canadian Forces College, 2013.
- Prime Minister Harper, "Prime Minister Harper Announces New Offshore Patrol Ships," last modified [or accessed], 7 April 2015, <http://www.pm.gc.ca/eng/news/2007/07/09/prime-minister-stephen-harper-announces-new-arctic-offshore-patrol-ships>
- Robertson, Scot. "The development of Royal Air Force strategic bombing" *Airpower Journal* 12, no. 1, (Spring 1998): 37-52
- Roi, Michael L. "Russia: The Greatest Arctic Power?" *Journal of Slavic Military Studies*, Vol. 23 Issue 4, (Oct-Dec 2010): 551-573; <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=55598231&site=ehost-live; Internet; accessed 16 Dec 2014>.
- The School of Advanced Airpower Studies. *The Evolution of Air Power Theory*. Edited by Col Phillip S. Mellinger. Maxwell AFB, Alabama. Air University Press, 1999.
- Segal, Hugh. *Geopolitical Integrity*. Montreal: the Institute for Research on Public policy, 2005.
- Shimooka, Richard. "Issues Analysis: Aerial Refueling, Northern Defence and the F-35." CDA Institute, February 2013; <https://www.cdainstitute.ca/en/blog/entry/issues-analysis-aerial-refueling-northern-defence-and-the-f-35>; Internet; accessed 15 Dec 2014.
- Smith, M.L.R, and Sophie Roberts. "War in the Gray: Exploring the Concept of Dirty War." *Studies in Conflict & Terrorism* 31, no. 5(May 2008): 377-398. <http://eds.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=c2f58683-e3ea-4506-96c6-99ddac3c80bf%40sessionmgr115&vid=8&hid=127>

- Smith, Hugh. "What Costs Will Democracies Bear? A Review of Popular Theories of Casualty Aversion." *Armed Forces & Society* (0095327X) 31, no. 4 (Summer 2005): 487-512. EBSCOhost (accessed April 14, 2015).
<http://search.ebscohost.com/login.aspx?direct=true&db=24h&AN=18333905&site=ehost-live>
- Smith, Richard K. *75 Years of Refueling History*. Washington: U.S. Government Printing Office, 1998; <http://www.afhso.af.mil/shared/media/document/AFD-100929-015.pdf>; Internet, accessed 17 Feb 2015.
- Stachiw, Anthony L. and Andrew Tattersall. *Boeing CC137 (707-347C)*. St Catherines, ON: Vanwell Publishing Ltd., 2004.
- Stewart, Brian. "Putin gets Payback for Canada's anti-Russia stance" CBC News, 27 June 2014, last accessed [or modified] 13 April 2015,
<http://www.cbc.ca/news/politics/putin-gets-payback-for-canada-s-anti-russia-stance-brian-stewart-1.2688655>
- Stouffer, Ray Major. "Cold War Air Power Choices for the RCAF: Paul Hellyer and the selection of the CF-5 Freedom Fighter," *Canadian Military Journal*, Autumn 2006; <http://www.journal.forces.gc.ca/vo7/no3/doc/stouffer-eng.pdf64>; Internet; accessed 9 January 2015.
- Stratfor. "Russia's Military Preparations for the Arctic." Stratfor Analysis Nov 2013.
<http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=94089607&site=ehost-live>; Internet; accessed 16 Dec 2014.
- United States. Government Accountability Office. "Air Force Assessment of the Joint Strike Fighter's Aerial Refueling Method." Washington: March 14, 2005;
<http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=18174701&site=ehost-live>; Internet; accessed 8 December 2014.
- United States. Government Accountability Office. "Military Aircraft: Observations on the Proposed Lease of Aerial Refueling Aircraft by the Air Force." Washington: GAO, September 2003;
<http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=18209994&site=ehost-live>; Internet; accessed 8 December 2014.
- United States. Government Accountability Office. "Military Aircraft: DOD Needs to Determine Its Aerial Refueling Aircraft Requirements." Washington: GAO, June 2004;
<http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=18174211&site=ehost-live>; Internet; accessed 8 December 2014.

- United States. Government Accountability Office. "Military Aircraft: Observations on DOD's Aerial Refueling Aircraft Acquisition Options: GAO-04-169R." Washington: GAO, October 2003; <http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=18210146&site=ehost-live>; Internet; accessed 8 December 2014.
- United States. United States Air Force. Analysis of Alternatives (AoA) for KC-135 Recapitalization Executive Summary. Rand Corporation, Contract F49642-01-C-0003, 2006
- United States. Government Accountability Office. "Military Aircraft: Institute for Defense Analyses Purchase Price Estimate for the Air Force's Aerial Refueling Aircraft Leasing Proposal," GAO-04-164R, October 2003; <http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=18210145&site=ehost-live>; Internet; accessed 8 December 2014.
- United States. Department of Defense. *Joint Publications 3-17 Air Mobility*, 2013. CD-ROM.
- United States. National Oceanic and Atmospheric Administration. "Arctic Change," last modified [or accessed] 23 March 2015, <http://www.arctic.noaa.gov/detect/global-temps.shtml>
- United States. United States Marine Corps. "Marine Corps Operations," Marine Corps Doctrinal Publication (MCDP) 1-0, 2011.
- Vachon, L. "Véhicules Aériens sans Pilote pour assurer la Souveraineté de L'Arctique: Est-ce Nécessaire et Faisable?" Masters of Defence Studies, Canadian Forces College, 2013.
- Voronov, Konstantin. "The Arctic Horizons of Russia's Strategy." *Russian Politics and Law*, vol. 50, no. 2, (March–April 2012): 55–77; <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=74132266&site=ehost-live>; Internet; accessed 16 Dec 2014.
- Wilson Rowe, Elana and Blakkisrud, Helge. "A New Kind of Arctic Power? Russia's Policy Discourses and Diplomatic Practices in the Circumpolar North." *Geopolitics*. Vol. 19 Issue 1, (Jan2014): 66-85.
- Winnefield, James A., Preston Niblack and Dana J. Black. *A League of Airmen: U.S. Air Power in the Gulf War*. Santa Monica: RAND Publishing, 1994.
- Zysk, Katarzyna. "Russia's Arctic Strategy." *Joint Force Quarterly*, Issue 57, (2010 2nd Quarter): 103-110; <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=51204636&site=ehost-live>; Internet; accessed 16 Dec 2014.