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FINDING EFFICIENCIES IN OPERATION BOXTOP

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The future Air Force must be capable of sustaining itself to project power effectively and quickly, anywhere and at any time. Air Force sustainment must be mobile, robust, flexible, responsive, technologically superior and fully interoperable. It must balance capabilities and requirements for both material and personnel. In essence, it must be constant and consistent to be relevant and combat effective.

-CFAWC, Projecting Power: Canada's Air Force 2035

INTRODUCTION

Canadian Forces Station (CFS) Alert is a Signals Intelligence (SIGINT) facility operated in the High Arctic on behalf of the Government of Canada by the Canadian Armed Forces. "The role of CFS Alert is to operate and maintain signals intelligence and geolocation facilities."[1] While its primary mission is SIGINT, it also conducts sovereignty missions and supports scientific research. Due to its remote location and hostile environment it needs to be re-supplied by air. That sustainment operation is called BOXTOP.

Operation (Op) BOXTOP is the primary source of fuel and logistics sustainment to both CFS Alert and Fort Eureka each year. It is done over two separate periods, one in the spring after daylight returns, and one in the fall before full darkness. Each Operation is planned for a period of approximately three weeks during which time Royal Canadian Air Force (RCAF) aircraft will be staged out of Thule Air Base (AB), Greenland with one aircraft based at CFS Alert. The single aircraft staged from Alert will be dedicated to the transport Ultra-Low Sulphur Diesel (ULSD) from Resolute, Nunavut, while the preponderance is used for air-bridge sorties between CFS Alert and Thule AB.

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[1] Canadian Armed Forces, *Canadian Forces Organization Order (CFOO) 261200z - 0208 CFS Alert* (Ottawa, ON: Canadian Armed Forces, 2008).

The spring, or wet, Operation BOXTOP is focused on fuel re-supply; Jet Propellant 8 (JP-8) for aircraft, DF-8[2] for heating, and ULSD for vehicles. The fall, or dry, Operation BOX-TOP is focused on ferrying the supplies shipped by barge from the Port of Montreal to Thule AB early in the summer, and usually consists of construction materials, dry goods, spare parts for equipment and machinery, and a fuel farm top-up. On average the modern Operation BOXTOP is a round-the-clock operation which consists of approximately 50 augmentees at CFS Alert and 100 Thule AB. The personnel come from a number of trades which include pilots, air combat systems operators (formerly navigators), flight engineers, load masters, maintenance technicians, logistics, and traffic techs in mobile air movement sections (MAMS), along with a number of other trades in support roles. The RCAF normally tasks 3-4x CC-130 Hercules, 1x CC-177 Globemaster III (RCAF designation for the Boeing C-17), and 1x CC-150 Polaris (RCAF designation for the Airbus A310-300) for passenger transport and light cargo between 8 Wing Trenton and Thule AB during the deployment and re-deployment phases of the operation.

During the two Operation BOXTOP of 2015, there was 54,844 kg of cargo delivered to Alert (177,004 kg in 2014), none to Fort Eureka (15,422 kg in 2014), 1,400,474 litres (750,000 litres in 2014) of JP-8/DF-8 to Alert, and none to Eureka (65,000 litres in 2014), and 242,224 litres of ULSD to Alert.[3] In addition to Operation BOXTOP, CFS Alert receives weekly Sustainment Fights in order to provide fresh food and ongoing re-supply. For the 2015 Operations, maintenance and weather forced reduced amounts for deliveries, and the contingency plan was to

[2] George Stewart, RE: Boxtop II/15 - CFS Alert BOXTOP Sealift- 09:32, 19 January, 2016. Prior to 1995, Thule AB had been using Diesel Fuel Arctic Grade but switched to NATO Standing Agreement (STANAG) Single Fuel Concept. DF-8 (the acronym is said to be domestic fuel-8) is the term used to differentiate the two fuel uses; JP-8 simply being triple filtered prior to use in aircraft and stored in completely separate tanks. Today the term DF-8 is still used for accounting purposes; however it is simply JP-8 that is offloaded from aircraft; there is no longer any difference in the filtering. In order to maintain the flight safety of aircraft, the fuel is offloaded into separate fuel farms and fuelling systems at CFS Alert, ensuring that they are never mixed.

[3] . *Op BOXTOP 01/15 SITREP- Final, 250800Z APR 15 (Thule AB, Greenland: Airlift Control Element, [2015]).*; *Op BOXTOP 02/15 SITREP NO 11, 090000Z OCT 15 TO 092359Z OCT 15 (Thule AB, Greenland: Op BOXTOP Airlift Control Element, [2015]).*

use the sustainment flights to make up the difference, so as to ensure that the fuel farms are stocked with enough to sustain the Station and conduct air operations. The majority of sustainment flights use CC-130J, with approximately one quarter flown by CC-177. The spring and fall combined 2015 Operation BOXTOP costs were $5,041,428.70.[4] It should be noted that this costs does not take into account the costs associated with operating the aircraft, whether neither fixed costs or full-up costs, nor does it take into account the fuel required for the flight operations themselves.

Due to the costs associated with operating a Station in such a remote location and harsh environment, it would be beneficial for the RCAF to examine cost saving measures. Such alternatives for cost reductions associated with the Station can occur in a number of ways. This study will focus on ways in which Operation BOXTOP can be optimized in order to reduce those costs, and it can occur in a number of ways. This paper will examine how a reduction in Operation BOXTOP, through recommendations for CFS Alert and creative strategies on the part of the RCAF, can realize dramatic cost savings for the RCAF. Furthermore, these cost saving measures will be examined through the lens of both Arctic and global air mobility operations in order to provide potential cost saving across the Canadian Armed Force (CAF).

Much has been written on the Arctic, yet little covers the topic of CFS Alert or Operation BOXTOP directly in the manner in which this paper will examine the subject of finding efficiencies in the operation. A few notable books and papers have been written that provide a historical overview of the Station and operation, notably Gray's history of the Station, Heidt and Goette's

[4] Captain D. Gosselin, Re: BOXTOP Costs, 23 February 2016, 2016. While the numbers can change dramatically each year, the intent is to provide the max amounts of fuel and cargo. This changes each year as their use does, hence Mr. George Stewart, whose job it is to plan sustainment operations for CFS Alert, will determine the required amounts annually. When the planned amounts differ significantly from the delivered amounts, the sustainment flight is used to make up a difference. CJOC and the RCAF no longer consider adding a third BOXTOP due to costs associated with their operation.

history of Operation BOXTOP, Heide's examination of lesson learned through the Alert Wireless Station, along with a few outstanding newspaper articles that have been written on CFS Alert over the decades. Additionally, a number of academic papers have covered the topic of the paper in a peripheral manner such as Legge's dissertation on Arctic security, Poitras's Arctic search and rescue research paper, and Ziprick's research paper on air mobility support to Canadian Arctic Sovereignty.

Defence Research and Development Canada, in conjunction with Natural Resources Canada conducted an exhaustive study of energy usage at the Station. This collection of reports and recommendations form the basis for my section in Chapter 3.

Other works include passing references or merely allude to Alert and Operation BOXTOP, like the Canada First Defence Strategy and other Government of Canada policy papers on the Arctic. However, none of the aforementioned works have examined the topic of finding quantifiable efficiencies which the RCAF can implement which would result in both a fiscal and flying hour savings.

Aside from the operational methods to reduce costs associated with Operation BOXTOP in Chapter 2, which include a focused use of the CC-177, various options are examined throughout this study that would require investments, but would provide potential for high return on investment. These include the construction of a hangar and/or pier at CFS Alert that would dramatically change the way in which the Station could be re-supplied, and will be discussed in Chapter 2. Either could provide benefit to the Station by either reducing costs for the housing of operating from Thule AB or by the shipping of supplies directly to the Station by barge. Either would create additional opportunities for sovereignty operations by air or sea from CFS Alert. However, each of these options would require long-term planning for CFS Alert from the RCAF, and at

least Canadian Forces Information Operations Group (CFIOG) as it would likely take greater than a decade to realize either project with costs estimated in the tens of millions of dollars for each option.

Chapter 3 will examine the use of Canadian airfields like Iqaluit vice the continued reliance on our American partners at Thule AB. The possibility of improving the current North American Aerospace Defense Command (NORAD) Forward Operating Location (FOL) in Iqaluit[5] for CFS Alert sustainment operations could be one method that would allow for sustainable future operations in the High Arctic. Due to current infrastructure and facilities in Iqaluit, it would necessitate a concerted effort and would result in economic benefits in the region; a potential Whole of Government (WOG) approach that would benefit not only the community, but a number of federal and territorial departments as well.

Using contracted civilian commercial air carriers instead of RCAF assets has been an option the CAF has used in the past. This paper will examine the potential benefit of a contracted air delivery method, novel ideas for sustainment operations in the form of airships, and some of the implications that would have on the cost as well as Force Generation (training) of RCAF aircrews.

Improved inventory management practises at CFS Alert would go a long way to reducing the cost of supplies flown to the Station. It is worth noting that because all supplies are flown to the Station, any reduction in that actual amount of supplies needed/ordered equates directly to fuel savings on aircraft, thus reducing costs. This optimization of supplies can be realized in a number of areas, and will be explored in Chapter 3 along with other non-operational methods to find efficiencies in Operation BOXTOP.

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[5] Andrea Charron and James Fergusson, *NORAD in Perpetuity? Challenges and Opportunities for Canada - UNCLASSIFIED* (Winnipeg, MB: University of Manitoba Centre for Defence and Security Studies, [2014]), 39.

At the present , many of the food supplies are bulk-purchased for the Station and due to a variety of reasons they are not always used prior to expiry dates, thus increasing the costs associated with the Station due to a requirement to purchase food items multiple times. The paper will look at option for better food management practises that will help to alleviate this issue and reduce costs.

Another area of concern is the inventory management of the Construction Engineering (CE) section and Transport sections. Both of these sections prefer to have a supply of materiel on hand rather than purchase just-in-time, as this method has proven to dramatically decrease the time delay for those parts to reach the Station and thus whichever item and/or vehicle is returned to service. Unfortunately, due to a combination of factors, there are parts throughout the Station that can't be found, that no one knew existed, which have expired, become obsolete, etc. Each of these situations translates into fuel for aircraft to bring them in, to bring in replacements for them, and to take those out when they become expired. By introducing an inventory management system, there would be cost savings seen in the fuel required for transport aircraft.

Defence Research and Development Canada (DRDC) has been looking at energy savings for CFS Alert over the past six years or so. They conducted a number of in-depth studies that covered areas as diverse as the insulation of structures in the High Arctic, cost effective lighting, and more efficient heating and cooling systems. Through the work of Gisele Amow and her colleagues at DRDC, the RCAF was given a roadmap of items that could be fixed and/or adjusted along with estimated costs for implementation and potential cost savings. If implemented, each of these items would see a reduction in demand for DF-8 fuel required to power the Station and thus reduce the reliance on Operation BOXTOP.[6]

[6] Gisele Amow, *Alert Energy Measures Statement of Work* (Dartmouth, NS: Defence Research and Development Canada, [2013]).

Diverse methodologies and approaches are available in order to conduct a comprehensive examination towards finding efficiencies in Operation BOXTOP. Through extensive scrutiny of the operational, non-operational, and future means through which efficiencies may be found, this paper will present a road map through which the RCAF can save money and flying hours, therefore enabling them to be allocated elsewhere.

Regardless of the end-state of this research, in order to establish the cost savings potentials in Operation BOXTOP, it is essential to gain an understanding of the history of Ellesmere Island, the Station, and the evolution of the operation. In examining how Operation BOXTOP evolved into its current iteration, the RCAF will be better positioned to provide the Station with the sustainment which it needs to conduct operations which will be robust, flexible, responsive, and fully interoperable.[7]

[7] Royal Canadian Air Force, *Projecting Power: Canada's Air Force 2035* (Astra, ON: Canadian Forces Aerospace Warfare Centre, [2009]), 90.

HISTORY

Introduction

CFS Alert is located in one of the most austere and isolated environments on the planet. This has presented the Canadian Armed Forces with myriad problems in determining the best methods in which the Station can be sustained. Therefore it is critical to provide a historical overview in order to establish many of those sustainment challenges that have existed since the Station's inception in order to provide recommendations on its future.

CFS Alert began as a Joint Arctic Weather Station (JAWS) on the northern tip of Ellesmere Island in 1950, making it the most northern permanently-inhabited community on the planet. Its location at 82°29'58" N, 62° 20'5" W, only 817 km from the North Pole, means that the nearest modern-day settlement is Grise Fiord (population of around 150), which lies 800 km south of the Station.[8] At its height with a population around 300, CFS Alert was the biggest settlement on Ellesmere Island, more than doubling its nearest neighbour. It was not until 1956 that Alert began an additional duty as an experimental wireless station of the RCAF. In 1958, it became Alert Wireless Station once its experimental wireless duties became operational under the command of the Canadian Army; and the environmental duties of its Department of Transport personnel became secondary to the operational nature of Alert.[9]

History of the Region, Early Expeditions, and the Station's Namesake

Prior to the establishment of the JAWS site, the northern tip of Ellesmere Island was an inhospitable place that was only sporadically inhabited.

The sporadic habitation of Ellesmere Island can be seen in the CFS Alert motto, *Inuit Nunangata Ungata*, which means "Beyond the Inuit Land." It is so far north that even those Arc-

[8] Rick Boychuk, "Grise Fiord's Cold Warriors," *Canadian Geographic* 128, no. 5 (October 2008): 1.
[9] David R. Gray, *Alert: Beyond the Inuit Lands* (Ottawa, ON: Borealis Press, 1997), xiii.

tic cultures throughout history avoided permanent settlements due to the climate and a general lack of resources; making it dramatically inhospitable without continual re-supply. That is not to say that northern Ellesmere Island was bereft of occasional or seasonal settlement, in fact it has a "rich archeological record [which] shows that Arctic peoples [have] inhabited [the region] for more than 4000 years."[10]

Evidence of aboriginal cultures near Alert can be seen in the archeological record of their camps, one of which can be found as close as 12km from the station at Wood River, where a stone tent ring and hearth were discovered in 1961. The Thule people also left remnants of their culture as far north as 95km northwest of CFS Alert at Clements Markham Inlet; only 40km south of the most northern point of land on earth.[11] However, these sites share one similarity: they were seasonal sites, and were abandoned in the winter in favour of those further south on the island due to the climate.

Artifact findings prove not only direct contact with the Norse, but also suggest continued contact with other Arctic communities on the Island and Greenland. Around 1700, the Thule peoples abandoned Ellesmere due to a 50 year period of exceedingly harsh winters; moving to Greenland and settling there. This marked the end of known permanent habitation before modern times.[12] Thus for a period of approximately 250 years, Ellesmere Island had no permanent habitation due to isolation and climate. Resources were needed to survive in the High Arctic and they were not possible until the 1950s when it became apparent that aircraft could fill that sustainment role.

The first recorded modern visit to the area took place in 1871, when the U.S. North Polar Expedition of 1871-1873 reached maximum latitude of 82^{o} 11'N 30 August 1871. However, one

[10] L. David Mech, "Life in the High Arctic," *National Geographic*, June 1988, 1988, 762.
[11] Gray, *Alert: Beyond the Inuit Lands*, 2.
[12] Peter Scheldermann, "Eskimo and Viking Finds in the High Arctic," *National Geographic*, May 1981, 1981, 575.

of the first recorded instances of western visitation to the area around what is now CFS Alert occurred in the winter (winter being late August to late June at that latitude) of 1875/1876. That was the year that Her Majesty's Ship (HMS) *Alert* wintered approximately 10km from the present location of the Station. [13]

On 9 Sept 1875, a team of four officers and four men from HMS *Alert* set out from Cape Sheridan with three sledges and twenty one dogs in order to explore a route for future crews. The HMS *Alert* was wintered at Cape Sheridan- 10 km east of modern CFS Alert- and locked in the winter ice.[14]

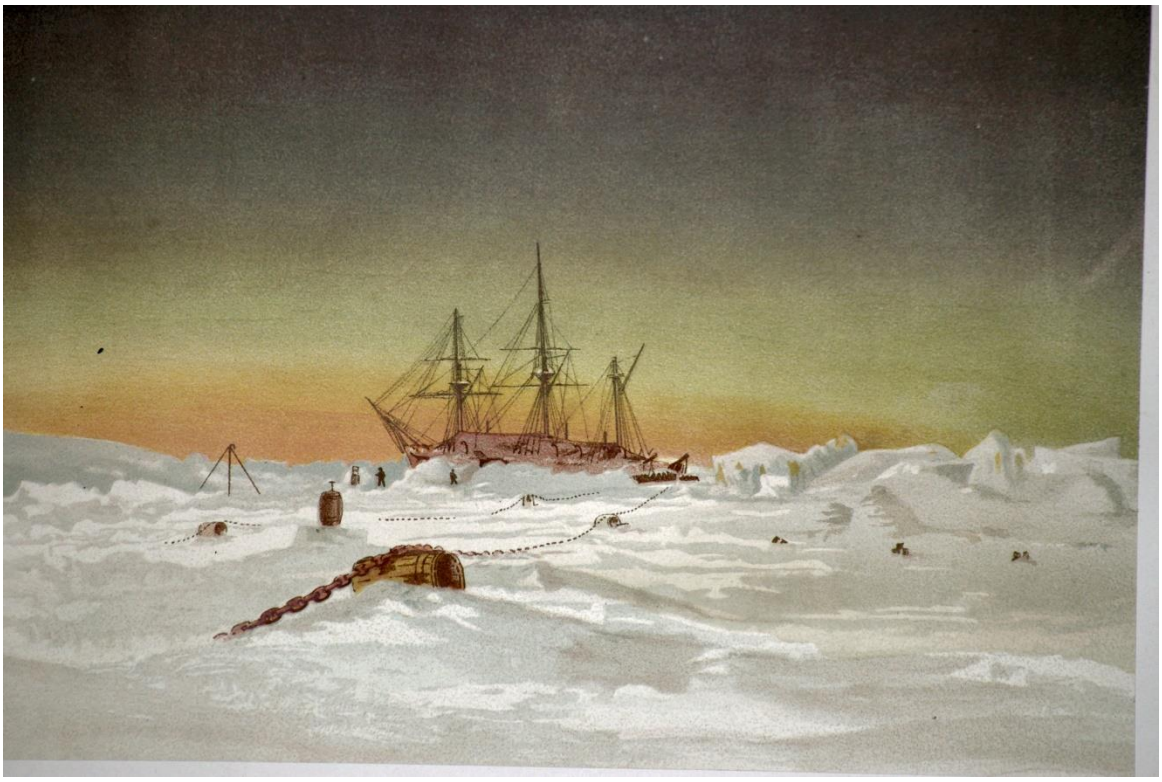

Figure 1.1 – HMS Alert wintering at Cape Sheridan

Source: Moss, *Shores of the Polar Sea, Chromograph X,* 52.

[13] Gray, *Alert: Beyond the Inuit Lands*, 3.
[14] Dr Edward L. Moss, *Shores of the Polar Sea: A Narrative of the Arctic Expeditions of 1875-6* (London: Marcus Ward & Co., 1878), 32.

This was the harshest of environments in which the crew of the Alert wintered. The ship was successful in exploring further north than anyone at that time. During their time locked in the ice they not only explored areas previously unseen by Europeans, they discovered and named Dumbbell Bay, the present day location of CFS Alert. To this day the water in the narrows, in which they found their seal in 1875, rarely freezes solid enough to walk on and seals are often seen nearby.

Figure 1.2 – CFS Alert above Dumbbell Bay. The narrows are at the lower right.

Source: Author

The naturalist from the HMS *Alert*, Capt Henry Feilden, made a number of journeys inland throughout the wintering of the ship in order to improve scientific knowledge of the region and to collect specimens, as was common in an era in which everything was drawn by hand. He is also responsible for some of the earliest known photography of the Arctic, which he took dur-

ing expeditions to the Winchester Hills found about 8 km from the Station.[15] He was instrumental in determining the geology of Northeastern Ellesmere Island, and returned to England with 2000 specimens collected during the expedition.

Figure 1.3 – HMS Discovery during the British Arctic Expedition 1875-1876.

Source: Capt Henry Feilden, Norfolk Museums

At Floeberg Beach, the wintering location of the HMS *Alert* and stepping-off point for all expeditions that winter, are the graves of two members of the expedition as well as the Alert cairn erected in 1876.[16] The graves are common locations for visitors to ponder the struggles of the expedition members and to consider their own commonality in being so far from family and isolated in similar manners; separated by more than 140 years. HMS *Alert* remains a common historical link to Station personnel; in fact, the recently relocated and renovated library was named in honour of the *Alert* and her crew, along with the hardships they faced in the environment surrounding the modern Station.

[15] The Winchester Hills are now commonly referred to as Crystal Mountain due to the sheer volume of quartz crystal littering the landscape and the decades of Alert personnel visiting and collecting their own outstanding specimens.
[16] Gray, *Alert: Beyond the Inuit Lands*, 5. These are the grave of Niels Christian Petersen, a Danish Interpreter who died of severe exposure suffered during a trip between HMS *Alert* and HMS *Discovery*. The other grave is that of George Porter, a gunner in the Royal Marine Artillery who died while away from HMS *Alert* on a sledge.

The United States (U.S.) conducted further expeditions of the Island in 1881-1882 during which Lieutenant A.W. Greely, as expedition leader, established Fort Conger in Discovery Harbour[17], part of Lady Franklin Bay, approximately 100 km south of the Station. Once their ship had departed, Lieutenant Greely and his men spent the following year exploring, and were responsible for determining much of the geography of the area including "Lake Hazen, and the fiords of western Ellesmere Island, and the coast of northwest Greenland. At the end of their first winter, a three-man party…travelled north along the coast…reaching the Feilden Peninsula"[18] This exploration also took them through the current location of the Station, but noted nothing other than limited wildlife along the way.

Robert E. Peary's expeditions of 1898-1909 made a number of trips through the region immediately surrounding modern CFS Alert. They often set up caches in the area, in part due to scarcity of supplies and animals.[19] They reached Cape Sheridan near CFS Alert a number of times, overwintering there in 1908/09. As their ultimate goal was the North Pole, they used Cape Sheridan as a staging point and pushed northwest to Cape Columbia over a three day period; covering 150 km. They hunted caribou and musk oxen in the area and artifacts from their expeditions are also found in the Alert Museum, to include tin fuel cans.[20]

The last of the Arctic expeditions to pass through the area is the Norwegian Expedition of 1920. It was responsible for the establishment of fuel and survival caches in support of Roald Amundsen's planned trans-polar flight. These caches spanned as large swath of the northern Island near Cape Columbia and Depot Point, which is 13 km west of Alert. They were never used,

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[17] Discovery Harbour was named for the HMS *Discovery* of the British Arctic Expedition of 1875/1876 as the location of her wintering.
[18] Ibid., 6.
[19] While the number of caches has increased over the 65 years of Station operations, some of the original caches can still be seen.
[20] John Allemang, *"How to Survive on the Edge of Nowhere: Life at Canadian Forces Station Alert" Globe and Mail,* 21 May 2015.

and Station personnel visited two sites in 1953 to find the food rations still edible, thirty years later.[21]

One of the lasting legacies of these collective expeditions is their artifacts. It is now DND policy that no archeological artifacts are to be removed from any site and anyone found having done so will be charged.[22] Artifacts are now being incorporated into a part of the RCAF Museum to include all of that associated documenting, studying, and displaying of the artifacts so that CFS Alert is seen as a responsible caretaker and successor to these brave explorers.

Today only around 400 people live on Ellesmere Island; around 150 at Grise Fiord in the south (which was established in 1953 by the Government of Canada in an effort to bolster arctic sovereignty claims by moving communities from Hudson's Bay), 15 in Eureka in the west, and remainder at CFS Alert. The majority call CFS Alert home during the deployment.[23]

Determination for the Location of CFS Alert

CFS Alert was originally a Joint Arctic Weather Station (JAWS) created in response to the need for weather forecasting for aircraft and ships in the North Atlantic as a result of the Second World War. As historians Daniel Heidt and Richard Goette note,

> …this experience, combined with the rise of transatlantic commercial aviation, the desire to improve forecasting for southern Canada and the United States, as well as the Arctic's rising importance as a strategic theatre of operations during the early Cold War, led Canada, the United States, and Denmark to agree to construct several High Arctic weather stations.[24]

The United States Weather Bureau planned for JAWS locations in the Arctic from Banks Island in the Beaufort Sea all the way through northern Greenland. U.S. Congress approved the plan in

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[21] Gray, *Alert: Beyond the Inuit Lands*, 10.
[22] Canadian Forces Station Alert, *Station Standing Orders* (Alert, NU: CFS Alert, 2016)., 9.
[23] Mech, *Life in the High Arctic*, 750.
[24] Daniel Heidt and Richard Goette, "This is no 'Milk Run': Operation BOXTOP, 1956-2015," in *Canadian Arctic Operations, 1945-2015: Historical and Contemporary Lessons Learned*, eds. P. Whitney Lackenbauer and Adam Lajeunesse (Kingston: Canadian Defence Academy Press, 2016),. 286.

February 1946, with the Canadian Cabinet approval following in January 1947.[25] The stations, operated jointly by the Canadian Department of Transport (DOT) and the U.S. Weather Bureau (USWB) were responsible for synoptic surface and upper air observations. They contributed to the series of JAWS sites to provide forecasting for not only their region, but the greater North Atlantic, and by extension, the Arctic.[26]

In 1946, an early precursor to the modern Operation NANOOK took place, called Nanook 46, which carried supplies to Thule, Greenland in order to establish a U.S./Danish weather station. Part of the mission was to reconnoitre the surrounding areas to determine potential additional locations for weather stations using PBM Mariner flying boats and Bell helicopters. On 27 July, one of the aircraft conducted a reconnaissance sortie of the Lincoln Sea at the northern tip of Ellesmere Island and the Arctic Ocean in the area. The crew and Canadian observer noted a number of small lakes in the area along with a potential landing strip location. Based upon these descriptions and extensive knowledge of the geography of northern Ellesmere, it is likely that they describe the environs of modern CFS Alert; they had just found their ideal location.[27]

There had been a plan to establish the JAWS site at Cape Columbia, the most northerly point of land in Canada, but that location was unsuitable for landing of aircraft and was inaccessible by sea. However, during U.S. Navy (USN) Task Force 80's summer deployment in 1948 (summers and exploration time are very short in the High Arctic – often counted in weeks vice months); they found suitable locations at both Patterson River (approximately 30 km northeast of CFS Alert), and Dumbell Bay, which was chosen as the best location. They took into considera-

[25] Gray, *Alert: Beyond the Inuit Lands*, 11.
[26] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 286.
[27] Gray, *Alert: Beyond the Inuit Lands*, 11.

tion things like access by sea, potential ice landing locations while construction was underway, and access to fresh water, along with a "landscape suitable for weather observations."[28]

Equipment and supplies were subsequently offloaded by landing craft onto the beach. Once that beachhead was established on the north side of the narrows in Dumbell Bay, the offloaded materiel was cached until 1950 when the U.S. Air Force (USAF) was available for operations with the USN. During this time the decision for naming the station arose, with both Belknap (Cape Belknap is nearby and was named after a Union commander during the U.S. Civil War), and Alert, the name of Capt Nares' ship that had wintered nearby. After much deliberation on the most appropriate choice for the name of the Station, the Board of Geographical Names selected "Alert" on 6 January 1949.[29]

The purpose of the first aircraft to land at Alert was, like many modern Operation BOXTOP missions commonly do, to bring construction supplies and personnel to the station. It was a U.S. C-47 (military version of the DC-3) on skis. Those men started the bulldozer that had been left in 1948 without incident, and began to create an ice runway on Alert Inlet, which is directly below the current Station. This allowed for the remainder of the crew and supplies to be flown in from Thule, establishing a tradition of providing support of sustainment operations that has lasted more than 65 years. This first operation was conducted using aircraft from both the RCAF and USAF in order to maximize the short construction season.[30]

The initial staff composition of the JAWS was four U.S. and four Canadian men as permanent staff, along with an additional three men for airstrip construction, and one for carpentry. This marked the beginning of operations at the site, and the necessity and reliance upon outsiders

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[28] Ibid., 12.
[29] Natural Resources Canada, "Canadian Geographical Names - Alert", accessed 5 May 2016, http://www4.rncan.gc.ca/search-place-names/unique/OAAQK
[30] Gray, *Alert: Beyond the Inuit Lands*, 13.

and aircraft sustainment operations to keep them supplied. By the end of that summer, a 4000-foot runway had been completed along with buildings and the appropriate weather equipment. On 1 July, 1950, the first weather reports were transmitted, and the JAWS site became operational.[31]

1950 marks the year in which the military became the main source of sustainment for Alert operations, although it was not until 1956 that the military truly began its own distinct operations and commenced a period of rebalancing of the importance of the work at Alert. By 1958, the first Commanding Officer (CO) of Alert took command, representing the transition to a military installation. While this event marked a change in mission for the station, it should be noted that it has always maintained the weather forecasting capability along with support to both scientific research and exploration. It should be noted that modern CFS Alert continues its contribution to global weather research through the RCAF meteorology technicians providing weather for the airfield and surrounding area as well as the Global Atmospheric Watch laboratory which releases two radio, wind, sonde balloons a day to transmit temperature, pressure, and relative humidity in order to contribute to simultaneous releases world-wide.[32]

From establishment of the Station in the 1950s, CFS Alert has been an ideal place to set off on exploration and adventure, as well as conduct scientific research.[33] Examples of this from the last 65 years include research in to Arctic pollution and the Ozone Layer, a 25 year study of birds, the impact of the Station's sewage and waste on the environment, research into capacity and capability of various entities to conduct remote and isolated operations to include unmanned

[31] Rachel Lea Heide, "Frigid Ambitions: The Venture of the Alert Wireless Station and Lessons Learned for the Canada First Defence Strategy," in , ed. Lackenbauer, P. Whitney, March, W.A., Vol. 4, 2012), 114.
[32] Gray, *Alert: Beyond the Inuit Lands*, 105-114. World Meteorological Organization, "Global Atmospheric Watch," accessed 5 May 2016, http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html
[33] Bjorn Staib, "North Towards the Pole on Skis," *National Geographic*, February 1965, 1965, 254., 256.

ground vehicle and unmanned aerial vehicles, as well as sleep studies and light/dark studies on the personnel themselves.[34]

Although the Station is ideally situated to assist in the conduct of such experiments, its primary mission evolved from JAWS into a SIGINT facility. SIGINT is the collection of electronic signals used for communication and Alert is; "the Arctic's front-line listening post."[35] Since the listening post's inception, its mission has been to intercept Soviet signals and provide them to Canada and her allies; a critical mission during the Cold War. Because of its location, the Station was ideally suited to pick up radio communications between Soviet bases, submarines, ships, and aircraft."[36] This development has necessitated operating under a veil of secrecy to this day, along with decades of intentionally misleading information as to the exact nature of its capabilities.[37]

Mission and Early Years

The intensification of Cold War tensions by the early 1950s created a requirement to obtain SIGINT from the Union of Soviet Socialist Republics (USSR). In 1955, the UK, U.S., and Canadian Northern Site Surveys Conference made recommendations regarding the establishment of SIGINT sites that were co-located with existing airfields. These sites included Resolute Bay, Northwest Territories (now in the Territory of Nunavut), Nord, Greenland, and Alert. The latter was chosen for a number of beneficial reasons, but one of the primary ones is, as Gray has hypothesized, the fact that "Alert is after all closer to Moscow than to Ottawa, and is in a good position to listen…"[38]

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[34] Gray, *Alert: Beyond the Inuit Lands*, 105-114.
[35] John Allemang, *"How to Survive on the Edge of Nowhere: Life at Canadian Forces Station Alert" Globe and Mail*, 21 May 2015.
[36] Rachel Lea Heide, "Frigid Ambitions: The Venture of the Alert Wireless Station and Lessons Learned for the Canada First Defence Strategy," in , ed. Lackenbauer, P. Whitney, March, W.A., Vol. 4, 2012), 114.
[37] Gray, *Alert: Beyond the Inuit Lands*, 14.
[38] Ibid., 15.

The Canadian Northern Surveys Conference recommendations resulted in the construction of the SIGINT facility. At first it consisted of a single small hut 500-yards north of the weather station which evolved into a permanent listening post with a series of 5 buildings.[39] Over the following two constructions seasons, another dozen buildings were added, and the Royal Canadian Corps of Signals assumed responsibility from the RCAF for Alert Wireless Station on 1 September, 1958. Although there were fears that a lack of funding would end Station operations, by the end of April 1959 full funding approval for the Alert project was received from the Prime Minister, Minister of Finance, and Minister of Justice. This enabled further expansion in the summer of 1959 to include further SIGINT capabilities and the associate expanded manning requirements.[40]

While the Canadian Armed Forces is still reluctant to explicitly state the Station's mission and outright refuses to discuss capabilities, it has taken a more relaxed stance on CFS Alert and its mission in recent decades. This has meant greater awareness of the station amongst Canadians, as a variety of news and entertainment sources have been able to visit and report on/film the Station. These include reporters from the *Ottawa Citizen*, *Globe and Mail*, and *National Post*, along with the television series Ice Pilots NWT, and This Hours has 22 Minutes, to name a few. It is now open source, and widely reported, that the mission of the Station is SIGINT; which in itself was, for decades, classified.

The Apex of Operations and Modern CFS Alert

As the Station grew in terms of both operational objectives and personnel, it also necessitated an increase in the infrastructure. By 1975 the Station had grown to 32 buildings, and with it, the realization that consolidation of structures and their responsibilities was needed as the cost

[39] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 286.
[40] Rachel Lea Heide, "Frigid Ambitions: The Venture of the Alert Wireless Station and Lessons Learned for the Canada First Defence Strategy," in , ed. Lackenbauer, P. Whitney, March, W.A., Vol. 4, 2012), 114.

to heat disparate structures had increased dramatically. These 32 buildings had been built and added over 25 years in what may be considered more of an *ad hoc* manner than would be expected for a Canadian Forces installation of the time. The consolidation and expansion phase lasted from 1975 until 1984. This is far longer than one would expect for the commensurate effort required, but all construction materials had to be flown or shipped in, one cannot simply "walk to Home Depot when something breaks."[41] In conjunction with the extremely short construction seasons at such high latitudes, what may reasonably have been a 5-6 years project in the rest of Canada took almost 10 years.[42]

The 1980s saw the culmination this work as the Polaris Hall operations building was completed along with the new accommodation blocks (Chimo Hall, Ladner Hall, and Whitehorse Hall), and culminated in the completion of the Headquarters and Personnel Services (HAPS) building, Churchill Hall in 1984.[43] These were all connected via one hallway that allows the previously sorely missing freedom of movement between operations and accommodations, even in the worst weather conditions. This resulted in a reduction of the number of personnel that were stranded in buildings across the Station when weather conditions achieved their highest, and most dangerous, levels. The new accommodations blocks housed the majority of Station personnel, and each section was divided into "Houses" representing the jobs or perceived attitudes of the members. The senior staff, all ranks above Warrant Officer, remained housed in their traditional Hut 53 (separate from the new construction), a leftover from earlier times. By 1995, when

[41] Allemang, *How to Survive on the Edge of Nowhere: Life at Canadian Forces Station Alert.*
[42] Gray, *Alert: Beyond the Inuit Lands*, 54.
[43] Ibid., 81. All of the various Halls at CFS Alert were named after former Supplementary Radio Station sites. Once construction was completed, 1 Construction Engineering Unit was awarded the very first unit Chief of Defence Staff Commendation for their outstanding work in such hard conditions over most of a decade.

manning reductions began due to the remoting of the Station, they moved into the eastern second floor of Chimo Hall, where they live to this day.[44]

At its zenith, the station was home to over 300 people providing SIGINT monitoring and interpretation capability on behalf of the Government of Canada. Many of the personnel who served at Alert until 1998 were from the Communications Research trade, most commonly known as 291'ers.[45] In the mid-1990s however, the Canadian Forces Supplementary Radio System (CFSRS) Remoting Project was initiated with a goal of turning the sites at CFS Masset, CFS Gander (now 9 Wing Gander), and CFS Alert, and into remote collection facilities feeding their data to CFS Leitrim.

When the project was completed in 1998, there were only a few remaining SIGINT technicians required at CFS Alert to maintain the SIGINT equipment. Virtually all Station infrastructure remained however, yielding significant surplus capacity. As the success of personnel reductions at the Station proved that it could still accomplish their mission, it was determined that the majority of support trades could be returned to the CAF, and an alternate service delivery (ASD) concept was sought.[46]

A decade after the remote collection project was complete; a commercial support contract was initiated in 2008 to actively reduce the uniformed presence on Station to a perceived manageable minimum. This integrated approach, DND led with ASD support personnel now meets the needs of National Defence and other government departments (OGD) utilizing the Station, while maintaining a sovereign uniformed presence in the Canadian Arctic. Now that the ASD contract has been in place since 2008, the manning for CFS Alert averages about 125. At the

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[44] Ibid., 80.
[45] Ibid., 23. Their trade designation is 291, and is one of the only trades to ever be referred to simply by their trade number.
[46] Major S. G. Marshall, Welcome to CFS Alert, 18 November, 2014, 5.

high point of the summer construction and research season, it is not uncommon to see all 185 current bed-spaces filled. At the manning low point of Christmas, only around 70 people remain on Station. During the author's time as CO CFS Alert, the number of contractors remains relatively steady at around 40, the Environment Canada staff is 4-5, and the rest are military.

CFS Alert is currently composed of ninety buildings, with some nineteen major structures in the core complex. These were typically built between 1960 and 1998, and total approximately 22,500 square meters of facilities. The collective facilities provide all the necessary capability to live and work in the Arctic environment on a permanent basis. There is a 5500 ft. gravel runway, several kilometres of roads, a quarry operation, landfills, fuel farms, and scientific labs, water pumping station from fresh water lakes, a gymnasium, and antenna farms in the local area.[47]

In 2009, the RCAF took responsibility for CFS Alert once again, and it became a regular unit under 8 Wing Trenton, ON. From the authors time as CO CFS Alert, he found through interactions with myriad sections at 8 Wing that some personnel in Trenton believed that the Station was in some fashion a lodger unit of 8 Wing to its location; however it is listed under the Wing's official organization as an operational unit with the CO reporting directly to the Wing Commander. That said, it was also much more convenient to have CO CFS Alert report through the Wing Logistics and Engineering Officer (WLEO) as the preponderance of units that support CFS Alert at 8 Wing are part of the WLEO organization.[48]

The Alert Management Office (AMO) at 8 Wing was stood up to handle the issues that arise that may be better handled by personnel in Trenton, such as contractual issues, business planning, and sustainment operations. They work directly for the WLEO, and not CO CFS Alert, and are the primary coordination agency to support Station activities over the medium term and

[47] Ibid., 4.
[48] 8 Wing Trenton, "Logistics and Engineering," last modified 8 February 2016, http://w08-ttn-vmweb01.forces.mil.ca/cms/en/main/8WingUnitsandSquadrons/logistics.aspx

long term. Seasonal support operations, like Operation BOXTOP, are coordinated from the Alert Management Office, but are executed as a Canadian Joint Operations Command (CJOC) operation with access to all appropriate national resources. AMO is the continuity that CFS Alert needs due to six month rotations for all military positions and the work that the 4-5 members do on behalf of a Station that lies 4000km to their North is invaluable. Without their efforts, CFS Alert would be hard-pressed to accomplish its mission in the fashion expected of all Canadian Armed Forces units, and especially those that provide such high-level product for Whole of Government operations, and those of select allies.

History of Operation BOXTOP

From the beginning of the Alert JAWS site, aerial re-supply has been critical to its survival and operations. During the early years, the majority of the supplies were sent by ship to northern Ellesmere, but conditions often made delivery unreliable and dangerous. Regular sustainment by sea ended in 1953 during Nanook 53, when it was determined that it was simply not possible to rely on such methods due to the extreme condition of the area. That year, ice up to 40 feet thick met the USS *Staten Island*, a USN icebreaker that itself was a replacement for another vessel. During her voyage, dynamite had to be used in order to successfully attain that northern latitude. The ship was the first and last USN icebreaker to deliver "provisions, fuel, and other cargo supplies."[49]

The USN quickly determined that the perils of a sea voyage at such latitudes endangered their ships and personnel and therefore came to rely solely on aerial resupply.[50] 1954 saw a change in planning for the resupply in that the sea lift would be given to the Department of Transportation (then responsible for JAWS), and a civilian company was hired to sea lift cargo

[49] Gray, *Alert: Beyond the Inuit Lands*, 85.
[50] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 285, 289.

from the Port of Montreal to Thule; the standard that has continued to this day with the CAF responsible for the Station.[51]

These large sustainment operations which were the pre-cursor to Operation BOXTOP do not take into account the sorties that were required between them on an ongoing basis. These flights were initially conducted mostly by RCAF aircraft via airdrop until such a time as the runway in Alert had been improved to reliable and safe conditions in 1958. These air operations were extremely risky sorties which saw one of the 1950 sorties result in one of the most deadly crashes in the history at Alert. Upon completion of the runway at Alert, the aerial sustainment operations were conducted every 6 weeks.[52]

Due to the environment and isolation of northern Ellesmere Island, sustainment operations for CFS Alert have exacted their human toll. In July 1950, a Lancaster bomber from 405 Sqn in Greenwood, Nova Scotia crashed during an ice reconnaissance and resupply flight killing all nine crew and passengers.[53] The contributing factors of the crash were twofold; the runway was not completed and thus sustainment was required through the far more dangerous air drop, and the air drop supply parachute was caught in the elevator at the tail of the aircraft, causing it to lose control and crash.[54]

August 1950 saw a Canso flying boat land in Dumbell Bay in an attempt to deliver the crash investigators for the recent Lancaster crash, and recover the remains of the Lancaster crew. While attempting take off, the flying boat struck the shore and was far too damaged to take de-

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[51] Gray, *Alert: Beyond the Inuit Lands*, 85-86.
[52] Lieutenant-Colonel D. Ziprick, *Leveraging Air Mobility to Support Canadian Arctic Sovereignty* (Toronto: Canadian Forces College, 2014), 46.
[53] Bruce Campion-Smith, "Canadian Forces Flights are the Tenuous Lifeline to Alert, the Top of the World." *Toronto Star*, sec. Canada, 6 February, 2016, http://www.thestar.com/news/canada/2016/02/06/canadian-forces-flights-are-the-tenuous-lifeline-to-alert-the-top-of-the-world.html
http://www.thestar.com/news/canada/2016/02/06/canadian-forces-flights-are-the-tenuous-lifeline-to-alert-the-top-of-the-world.html
[54] Gray, *Alert: Beyond the Inuit Lands*, 97.

part without significant repairs.[55] It was then decided to inter all of the Lancaster crew at CFS Alert and no longer attempt recovery.

In 1952 a USAF C-54 tasked to bring fuel to the Station also crashed. None of the crew died, and the remains of the aircraft were simply pushed off the side of the runway where they still sit; an ever-present reminder to aircrew and Station personnel of the difficulties of air operations in the far north.[56]

More recently, in 1991, a Hercules transport, call sign Boxtop 22[57], crashed into a hillside during its approach. Survivors huddled in the shattered fuselage for 36 hours in -23^{o}C weather awaiting rescue. Five died in the accident and there were thirteen survivors.[58] This was by far the most challenging air disaster at CFS Alert to date and tested the limits of Canada's Search and Rescue (SAR) capability and included assets from Canada and Greenland. The landscape, weather, and 24 hour darkness all played parts in the delay in reaching the crash site and rescuing personnel, and it prompted a number of procedure changes for RCAF Arctic air operations in order to attempt to mitigate further disasters.[59] Due to effects that may best be described as the

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[55] Ibid., 98.

[56] Ibid., 98. Due to the temperature extremes, metal takes far longer to deteriorate in the High Arctic than in the rest of Canada. The C-54 crash still appears like a recent crash.

[57] This instance on non-capitalization of Operation BOXTOP is intentional. While it is the modern method to capitalize all operation names, for aircraft call signs, it is the International Civil Aviation Organization (ICAO) standard not to.

[58] Major Dany Poitras, *Search and Rescue in the Arctic: Myth or Reality?* (Toronto: Canadian Forces College, 2013), 38-47. BOXTOP 22 crashed while on approach to CFS Alert on 30 October 1991. The crew withstood extreme temperatures and one member died from exposure in the -22˚ Celsius (up to -66˚C with the wind chill). Search and Rescue Technicians did not reach the crash site for 33 hours and the final casualties were removed 14 hours later. The primary reasons for the delayed response were a combination of distance from SAR assets, weather, and the geography of the Arctic environment itself.

[59] Royal Canadian Air Force, *Flight Operations Manual- Effective 0001Z 21 Mar 2016 to 0000Z 21 June 2016* (Winnipeg: 1 Canadian Air Division, 2016), 1044. 8 Wing Trenton, *8 WG OP BOXTOP OPERATIONAL PLAN 001/14* (Astra: 8 Wing Commander, 2014), 8. One of the issues that arose during the BOXTOP 22 accident investigation was that personnel were not dressed for the weather. Much of their Arctic cold weather clothing was put away and inaccessible, thus causing a greater emergency on the ground as many were dressed for weather in the south, not for severe cold and wind chill. Now all military members have to have a specific bag for their Arctic clothing called a B25 kit, which is kept in close proximity to the passengers on transport aircraft. This is done so that in the event of an emergency, it may be possible to recover your gear and thus provide a better chance of survival. No passenger or crew is allowed aboard an aircraft that will be operating in the Arctic without their B25 kit. People

Principle of Recency, the 1991 crash rests at the forefront of most discussions and memories of air disasters in the High Arctic, and for better or worse, its impact will take much longer to fade. Although Boxtop 22 was the most recent crash, others have proven their lasting impact upon the costs of Operation BOXTOP and general sustainment of CFS Alert. The graves of the Lancaster 905 crash are found near the end of the runway to this day, alongside the cairn erected in memorial to the crew of Boxtop 22. Both are powerful reminders of the challenges of working at Alert.

While ongoing sustainment operations were being conducted by the RCAF, the USAF had taken responsibility for the larger operations which had to take place two (and occasionally three times) a year. Once in the spring and once in the fall after the sea lift arrived in Thule from Montreal. These larger operations were conducted from Thule AB, which had recently undergone its own transformation from a JAWS to an AB after nuclear tensions between the Soviet Union and NATO led the Americans to build it as a strategic bomber forward operating location in the early 1950s. This included construction of a new 10,000 foot runway along with hangars that could be expected at most southern airfield. Establishing these facilities only possible given Thule's comparatively (to Alert) warmer environment and that it was nestled between mountains and a glacier on the Thule plain approximately 400 km south of Alert. Because of its location, services, manning, and ease of use, Thule AB because the defacto sustainment hub for Alert sustainment operations.[60]

These early sustainment operations into Alert, like many domestic operations of the time, were not initially named, and thus are more difficult to track through the veil of history. By the mid-1950s, the etymology of modern Operation BOXTOP began to take shape as early planners

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have been denied boarding for their own safety. 8 Wing is also tasked to maintain the ALERT 20-man Search and Rescue (SAR) kit.

[60] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 285-290.

first "[dubbed] the mission "Operation Boxtop"[61] in 1956 when Canada assumed full responsibility for the mission.[62] It has been theorized that the name is a derivation of the name of RCAF and USAF C-119 Flying Boxcars, which the RCAF used in the Arctic throughout much of the 1950s and 1960s, combined with the fact that they were flying at the top of the world. However, it was not until a few years later when the nickname found its way into official documentation, the first mention of which can be found in the May 1959 administrative procedures regarding the Station's expansion. The Quartermaster General noted that the USAF had dubbed the sustainment "Operation Box Top"[63]

Operation BOXTOP has evolved from the early years to become one of the RCAF's most challenging operations. Whereas early BOXTOP flights saw hundreds of tons of food and supplies they now consist of hundreds of thousands. Moreover, BOXTOP has become an opportunity for which junior aircrew, ground crew, and what are now referred to as Traffic Technicians and Mobile Air Movements Sections (MAMS) are able to gain tremendous experience while still flying in non-combat operations. As experienced air mobility officer LCol Darwin Ziprick has remarked, "in many respects, the challenges of operating in the North are similar to an expeditionary deployment such as the mission in Afghanistan".[64] Heidt and Goette agree, noting that "Operation BOXTOP also straddles the traditional distinction between domestic and expeditionary operations."[65] This can best be explained from two different aspects. First, expeditionary operations will of necessity include travelling through the airspace of many foreign nations which invariably will require coordination between air crews, 1 Canadian Air Division (CAD), Global

[61] This instance on non-capitalization of Operation BOXTOP is intentional. It is the modern method of the Canadian Armed Forces to capitalize the operation name, but this was not the case in the 1950's.
[62] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 289.
[63] Gray, *Alert: Beyond the Inuit Lands*, 92.
[64] Ziprick, *Leveraging Air Mobility to Support Canadian Arctic Sovereignty*, 45.
[65] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 288.

Affairs Canada (GAC), and the intended nation will be overflown. The second aspect is that travelling overseas also requires extensive planning for fuelling and crew rest (if three or more time zones are transited during the flight then additional crew rest is required as well), through to combat arrival checklists (depending on the type of mission) and contingencies; problems with which can be exacerbated through geography and time zones transited.[66] Travel to CFS Alert remains on Eastern Standard Time, and the only international location is Thule. However, since the operation has been ongoing for 65 years, the Standard Operating Procedures (SOP) are well established. Both factors mean that junior aircrew are more than capable of planning and executing an Alert sortie, while they may need more experience in the execution of other international operations.

The history of Operation BOXTOP includes the majority of transport squadrons in the RCAF that have provided support over the intervening decades. A number of squadrons have been deactivated and reactivated multiple times, and the majority have changed bases multiple times at least once. Due to the technological advances through the decades during which the sustainment operation has been conducted, all squadrons have invariably changed platforms (and their variants), and some have even changed roles. However, all squadrons are still extant today in RCAF service.[67] That is not to say that the RCAF was the only aerial support received; at various times and due to a number of issues that arose from weather to maintenance to operational commitments, the USAF has stepped in to sustain Alert either through direct contracting or simply support requests.[68] Commercial airlift has also been used in the past, and chapter 3 will look at the specific costs associated with such an enterprise.

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[66] Stewart, *RE: Boxtop II/15 - CFS Alert BOXTOP Sealift- 09:32*
[67] Gray, *Alert: Beyond the Inuit Lands*, 90-91.
[68] Ibid., 92.

Today the majority of sustainment and Operation BOXTOP sorties are carried out by 436 Transport Squadron (flying the RCAF's newest CC-130 Hercules variant, the J model), alongside the sorties carried out by 429 Transport Squadron (Sqn) flying the CC-177 Globemaster III. During Operation BOXTOP, 437 Transport Sqn assists with transport of personnel to and from Thule AB in their CC-150 Polaris. Both 436 and 429 Sqns are occasionally augmented by the remaining CC-130H Hercules squadrons from across the RCAF. These include 17 Wing Winnipeg's 435 Transport and Rescue Sqn as well as support from the other 8 Wing Trenton squadrons, 424 Transport and Rescue Sqn, 426 Transport Training Sqn, and 14 Wing Greenwood's 413 Transport and Rescue Sqn.[69]

Along with a wide range of transport squadrons that have sustained Alert, it should come as no surprise that there have been an even wider variety of aircraft, and variants, that have supported operations throughout its history. These include the earliest reconnaissance flights by USAF B-29 bombers, the earliest Airdrop operations by Lancaster bombers along with U.S. DC-3 Dakotas on skis, PBM Mariner flying boats, Vought OS-2 Kingfisher amphibious aircraft, USAF C-124 Globemaster, and some of the earliest use (1946) of a military variant of a Bell helicopter.[70] This helicopter was in all probability a Bell Model 47 as acquisition of the military variant, the H-13 Sioux (due to timelines available and reported deliveries of airframes), did not occur until 1947. Regardless of the exact model, it is still one of the earliest uses of helicopters in the Arctic, let alone the High Arctic.[71]

The aircraft of Canada's air force have spanned the decades and capabilities of the service. These include the previously mentioned Lancaster Bomber (airdrops), CC-119 Flying Box-

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[69] "Wings and Squadrons," last modified 20 November, accessed 5 March, 2016, http://www.rcaf-arc.forces.gc.ca/en/wings-squadrons.page

[70] Gray, *Alert: Beyond the Inuit Lands*, 89-90.

[71] "Bell H-13 Sioux Light Utility/Observation Helicopter (1947)," Military Factory, last modified 19 November, accessed 5 March, 2016, http://www.militaryfactory.com/aircraft/detail.asp?aircraft_id=1139

car, the CC-106 Yukon (Canadair CL-44s), CC-137 (Boeing 707s - Thule AB for support of Operation BOXTOP only), CC-144 (Bombardier Challengers- Thule AB for support of Operation BOXTOP only), C-54D North star (Douglas DC-4 Skymaster), C-47 (Douglas DC-3 Dakota), and all variants of the CC-130 Hercules, CC-138 Twin Otters, and the CC-177 Globemaster IIIs.[72] This variety of aircraft support not only highlights the length of time that sustainment operations at Alert have been ongoing, it infers an associated difficulty level in sustaining the Station with smaller transport aircraft. In the intervening 65 years, the advances that said sustainment has received as a result of the technological advancements have allowed far more rapid sustainment through one of the biggest transport aircraft in the world to support a Station so close to the North Pole by landing on the 5000' gravel/ice and snow runway.

Along with technological advancements, the support available and the speed at which it was delivered also changed dramatically. One of the most obvious aspects is the transportation of the fuel required to keep the Station operational. From the decades of fuel being delivered by drums that had to manhandled on and off each aircraft through the development, use, and iteration of the Bulk Fuel Delivery System (BFDS) which now allows upwards of 100,000 L to be offloaded from CC-177 during Operation BOXTOP. Sustainment has become easier, it has become, faster, but the requirements for Alert grow and change; all of which results in excessive costs associated with said sustainment, especially during Operation BOXTOP.

Conclusion

An examination of the history of the region is critical to understanding modern operations at the Station and impact the environment plays upon them. While the Station has only been extant for 65 years, the region has a much longer history that influences and helps shape modern

[72] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 285, 7-20.; Gray, *Alert: Beyond the Inuit Lands*, 90-93.

CFS Alert. From proto-Inuit through the Thule people and Arctic explorers, all have left their mark on the region. Operation BOXTOP evolved from early sustainment operations by airdrop and through the height of the height of the Cold War into its modern incarnation which now uses strategic airlift assets to move far more supplies in one aircraft than could be conceived of in the 1950's.

The very history to the Station and of BOXTOP itself speaks to current sustainment methods. However, like any military operation, the sustainment of CFS Alert has evolved and must continue to do so in order to find efficiencies, provide the best possible support to the Station, its mission, and its personnel, while making every effort to reduce the cost to the RCAF.

METHODS TO REDUCE THE COSTS OF OPERATION BOXTOP

Introduction

LCol Cathy Blue, the 8 Wing Logistics and Engineering Officer (WLEO) who oversees support to CFS Alert from 8 Wing Trenton, summarized Arctic operations succinctly: "this is the reality of working in the North. Things happen. You just have to roll with it."[73] Nothing truly works as one thinks it will, nothing happens as fast as one would need or like, the costs are always more expensive, and accidents will happen. This is a daily fact of life for most Arctic communities, and when one incorporates the isolation involved in everything related to CFS Alert, such challenges increases exponentially.

The focus of and meaning behind the word cost, as it relates to this paper, are related predominantly on the financial costs associated with sustaining CFS Alert; how can Operation BOXTOP be reduced in order to save money for the RCAF without impacting Station operations, and what does that savings mean. However, there are a number of other costs that must not be overlooked and will be examined. These include the loss of life and the costs on individual personnel away from home for BOXTOP, as well as what a reduction in BOXTOP would mean to the RCAF in terms of flying hours and training. These costs may be difficult to quantify, yet there are procedures, equipment, and other mitigation factors in place to reduce them. This chapter will examine the financial costs of Operation BOXTOP and provide recommendations on efficiencies and their fiscal impact.

Financial Costs

The financial costs associated with Operation BOXTOP each year change based upon a number of factors. These include the amount of cargo, fuel, and construction materials, and other

[73] Campion-Smith, *Canadian Forces Flights are the Tenuous Lifeline to Alert, the Top of the World.*, http://www.thestar.com/news/canada/2016/02/06/canadian-forces-flights-are-the-tenuous-lifeline-to-alert-the-top-of-the-world.html

materiel required for a given season. This may sound obvious, however what may be less apparent is the dramatic impact that weather and serviceability of aircraft play on the operational costs associated with Operation BOXTOP. Weather in the rest of Canada can have an impact on a given Wing's air operations. They may not be able to fly for a day or two due to severe weather, yet the intensity and variability of the weather at Alert cannot be understated. Storms can have such an impact at the Station as to completely shut down all outside activity due to complete loss of visibility (usually due to strong sustained winds), extreme cold temperatures, and others such as spring and fall fog banks due to changes in the ice in the surrounding Lincoln Sea.[74]

The weather is such a critical aspect to operations at the Station that the Storm Condition procedures are outlined in the Station Standing Orders (SSO). These procedures were meant to be practised, yet the author found that they were conducted so often for real-world conditions, that there was no need simulate storm conditions. Weather affects everything at Alert, sometimes with life-threatening consequences, and both personnel on the ground as well as aircraft operations are at risk; although air operations present much more extreme consequences. Mitigation is the key, but it cannot eliminate the threat.

The mitigation of prevalent weather conditions played a significant role in the historical and ongoing selection of Operation BOXTOP dates. While the weather in the winter months is generally far worse than at other times, it is often a factor, to a lesser degree, during the planned spring and fall operations; forcing the operation to pause or delay as the poor weather must be waited out. The weather can play a temporary role or it can cause a more dramatic impact. Delays due to weather, sortie cancellation, and even the early cancellation of the operation have all resulted from weather conditions and associated costs to BOXTOP. Along with time of year se-

[74] Rachel Lea Heide, "Frigid Ambitions: The Venture of the Alert Wireless Station and Lessons Learned for the Canada First Defence Strategy," in , ed. Lackenbauer, P. Whitney, March, W.A., Vol. 4, 2012), 115. Canadian Forces Station Alert, *Station Standing Orders*, 124.

lected to reduce the impact of weather, BOXTOP is planned for a three week period in order to provide additional days in the event of poor conditions. Every day that aircraft sit on the ground and fail to sustain the Station increases the costs of BOXTOP, not through direct flying costs, but the associated costs of housing and feeding all of the personnel.[75] While not the same scale as the cost of flying aircraft, delays still add up.

The costs for the personnel at Thule AB are $44 USD per night for quarters as well as $27.43 USD for food, and $17.30 Cdn for incidental expenses for a total of $110.16 (exchange rate as of 9 Apr 2016) per day. The Alert augmentees are not charged for rations and quarters as this is planned for in the Alert budget. However, all personnel supporting Operation BOXTOP at the Station will receive $17.30/day Cdn for incidental expenses. Therefore with an average of 100 personnel at Thule AB and 50 personnel at CFS Alert for Operation BOXTOP, every extra day of delay costs the RCAF $11,881.[76] While that may not seem like a significant amount, every day that BOXTOP is reduced will also help reduce these costs. If there were better, more accurate methods in which to predict weather (and they have improved dramatically over the decades of Arctic operations), then this would be less of an issue. Currently the weather is mitigated for BOXTOP in a number of ways.

The primary physical means in which weather is mitigated at Alert is through the deployment of 8 Air Communication and Control Squadron (ACCS). 8 ACCS is a "high-readiness, self-sustainable unit capable of deploying worldwide by air, land or sea. Its primary mission is to support Canadian air operations through the provision of a network enabled, controlled airfield, regardless of environmental conditions".[77] 8 ACCS is capable of establishing and controlling all

[75] George Stewart, Re: BOXTOP Costs- 12:21, 19 January, 2016.
[76] Ibid.
[77] "8 Air Communications and Control Squadron," last modified 29 December, accessed 5 April, 2016, http://www.rcaf-arc.forces.gc.ca/en/8-wing/8-air-com-and-control-squadron.page

airfield operations, be it a recently created airfield in an austere location or taking over an airport after a natural disaster, to every conceivable situation in between. It can deploy with a variety of equipment and capabilities, however during BOXTOP it employs its primary and secondary radars as well as its Precision Approach Radar (PAR), radios, navigation aids, and portable control tower. At Alert, 8 ACCS personnel incorporate their capability into the existing infrastructure and augment it in a way that makes it a force-multiplier for operations.

8 ACCS is able to control aircraft to a degree that the Station is incapable of throughout the remainder of the year. Their air traffic control radars and PAR bring unparalleled flexibility when they are employed by RCAF Aerospace Controllers (AEC)[78] and Aerospace Control Operators (AC Ops); neither of which are employed at CFS Alert year-round in the control of aircraft.[79] Using the PAR, 8 ACCS AC Ops are able to safely control aircraft down to 200 feet above the runway within ½ mile distance in virtually any weather condition and ambient light.[80] Under extreme conditions or training situations, and with aircraft commander approval, the PAR controller may control the aircraft to touch down; especially helpful in extreme weather conditions or aircraft emergencies. This capability enables 24/7 operations that are only required to be ceased for weather under the most extreme conditions (winds exceeding the ability of the radar mast to remain upright); unfortunately those conditions are not uncommon and continue to impact the operation of BOXTOP. However, 8 ACCS as a force-multiplier during BOXTOP ensur-

[78] AEC is the amalgamation of the former Air Traffic Controller (ATC) trade with the Air Weapons Controller (AWC) trade. While combined into the new trade in the 1990's, the officers in this occupation still spend most of their careers in one specialty or the other, one specializing in the control of aircraft at airports, and the other filling an air battle management role.

[79] Thompson, Master Warrant Officer Thomas, Briefing Note for 8 WComd- Employment of AC Op Flight Advisors at CFS Alert, 9 Sep 2014, 2014.

[80] Stewart, *RE: Boxtop II/15 - CFS Alert BOXTOP Sealift- 09:32* For comparison, under Visual Flight Rules (VFR), pilots must maintain 3000' visibility, 1NM horizontally from clouds, and 500' clear of clouds, and under Instrument Flight Rules (IFR) the conditions are more restrictive but still allow for airport operations under mot conditions. However, when weather falls below IFR minima, the only option is the use of a PAR. In addition to the PAR weather minimums, the unit was able to develop 4.5^{o} glide slope for the CC-177, which allows for faster approaches and thus cuts the length of time required for PAR operations essentially in half.

ing that weather is not nearly as much of a factor as in previous years, in which aircraft would have to restricted from operating far more often and for greater periods, driving up the BOXTOP costs. While they do not eliminate BOXTOP weather delays, they do mitigate the associated costs.[81]

Poor weather at Alert is often more of a problem than the weather at Thule AFB during BOXTOP. This is mainly due to Thule's location further south (700 km) than Alert as well as its location in a protected valley with hills on two sides and the Greenland ice cap to the east. That is not to say that Thule does not often have poor weather, but due to its location further south than Alert and its local geography, its poor winter weather usually ends prior to spring BOXTOP and starts after the fall op. Alert is on open land at the tip of Ellesmere Island with few hills to protect it and the geography causes an effect on the wind that may be likened to the Bernoulli Effect; the existing terrain funnels the winds through the area at faster speeds and more often. Weather problems for operation are so common that it has been written into the CJOC Operation BOXTOP Standing Order that termination of the operation will take place when either resupply of the Station is complete, or "flying becomes unsafe and further resupply cannot be achieved within an acceptable level of risk."[82]

The dates for BOXTOP are a result of experience over 65 years which provides the best weather potential for air operations on the gravel runway at Alert. The other environmental aspect that is taken into account is the shoulder season, which can last 3-4 weeks, and during which the runway is transitioning from a frozen state to its summer state. This is a difficult time for CC-

[81] Royal Canadian Air Force, "8 Air Communications and Control Squadron," last modified 29 December 2015, http://www.rcaf-arc.forces.gc.ca/en/8-wing/8-air-com-and-control-squadron.page
[82] Canadian Joint Operations Command, *CJOC STANDING OPORD - OPERATION BOXTOP 2015 TO 2020* (Ottawa, ON: Canadian Joint Operations Command, 2015), 10.

177 flying at Alert and they often won't be planned by the Joint Force Air Component Commander (JFACC- dual hatted as Comd 1 CAD when working for Comd CJOC) and CJOC in order to avoid the aircraft unduly sinking into the runway with no equipment to get it out.[83] Once the shoulder season is over, the runway crews are able to compact it enough that it is rarely an issue. Simple avoidance of the shoulder season does not imply that the runway is always in suitable condition during winter and summer as it should be remembered that it is a gravel and packed snow, semi-prepared runway. During BOXTOP, there are times that due to the sheer volume of aircraft movements in and out of Alert, the runway maintenance crews will have to take time to compact the runway and remove and ruts that have developed. The ruts and shifting runway conditions are very dangerous to aircraft operations, as the friction caused can pull aircraft around and contribute to accidents. During that period the operation is put on hold, but such actions rarely last longer than a couple of hours. Ensuring the runway is able to conduct sustained air ops is one of the most important roles of the permanent staff at Alert; without it, sustainment stops.

Serviceability of aircraft has always been a concern for global air mobility operations however; during Operation BOXTOP it can cause extensive delays as well as early termination of the operation. Because an aircraft sustaining Alert during BOXTOP can be located at Alert, Thule, Eureka, or even Resolute Bay when it breaks, it often requires at least a couple of days, if not more, in order to determine the issue and have parts flown in from 8 Wing Trenton. Weather and other factors can further complicate parts arrival, especially in locations like Eureka and Resolute Bay, neither of which have the benefit of 8 ACCS. Once the parts are received through a Maintenance Repair Party (MRP) they then have to be installed and a verification of systems must be undertaken in order to certify that the aircraft is safe to return to operations.

[83] Ibid., 3.

In some cases, especially at Thule AB, there may already be parts in place with the USAF units that can be used in order to repair aircraft. This may be accomplished under existing agreements with allied countries around the world which operate similar aircraft.[84] These agreements may be pre-established or operation/exercise dependant. This allows the parts to be used in a more timely manner (no need for an MRP to fly the parts in as well as their additional extra costs), and accounting is settled between the countries either in the replacement of like parts, or cost recovery.[85] This approach to aircraft maintenance has become more common in the past couple decades given the propensity for coalition operations. Countries will agree to carry certain parts for aircraft, such as propellers for a C-130 or tires for C-17, and each country will make up a small portion of the overall supply system in a given situation; reducing costs through shared supply chain management. Unfortunately, as BOXTOP is a Canadian operation, it therefore limits the potential such supply chain management may have in coalition operations to that which the USAF may have on hand. Even relatively minor maintenance issues may impact operations very quickly. During BOXTOP, the loss of the only CC-177 can and does have an immediate effect on the operation and its' costs.

During fall 2015 Operation BOXTOP, the CC-177 became unserviceable early on, having an immediate impacting on fuel delivery operations. After maintenance crews were able to determine the issue, they sought an engineering disposition.[86] An engineering disposition allows for the aircraft and crew the flexibility to fly home with an issue that would otherwise not allow

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[84] Defense Industry Daily, "The Global C-17 Sustainment Partnership", accessed 5 May 2016, http://www.defenseindustrydaily.com/did-focus-the-c17-global-sustainment-partnership-02756/ . The CC-177 has a global parts program that was purchased as part of the contract with Boeing that allows access to parts held by other nations through coordination with a Boeing representative.

[85] Major Adam Pentney, FW: JCSP Research Paper, 4 May, 2016. The CC-130J has a similar program to that of the CC-177. Other fleets, like the legacy Hercules (CC-130H) are loosely based on NATO STANAG's along with a certain amount of negotiating. Exercises more commonly have this aspect of supply chain management incorporated into planning.

[86] . *Op BOXTOP 02/15 SITREP NO 11, 090000Z OCT 15 TO 092359Z OCT 15 (Thule AB, Greenland: Op BOXTOP Airlift Control Element, [2015]).*

the aircraft to fly operationally without fixing said problem. So while the aircraft in question was allowed to fly home to Trenton in order to be repaired, it was not safe to continue the sustainment operation. This did avoid the costs that would have been associated with flying an MRP to Thule in another RCAF aircraft, but affected the operation in another regard. The impact in this case was obvious and dramatic; while BOXTOP was planned to deliver 1,300,000 litres of DF-8 to Alert during the fall operation, it was only capable of delivering 445,400 litres, or only 34.5% of the planned amount.[87]

This rather dramatic shortfall for the DF-8, which is used to run the generators for all heat and electricity, required some contingency planning in order to avoid making the situation much worse by running out of fuel during the winter. The "contingency plan is to extend future scheduled 85/86 [*sic*] [Alert] weekly sustainment to make up shortage".[88] This allows for the cessation of the BOXTOP operation on schedule, prevented additional costs of continuing with an unplanned and unfunded number of days, while ensuring that the fuel would still be delivered. Of note, this serviceability issue with the CC-177 did not reduce overall BOXTOP 2015 costs, nor would fuel delivery be expected to do so. It is part of the standing agreements between the RCAF and USAF that the fuel is still charged to the BOXTOP accounts, regardless of delivery date. This ensures less chance of errors when only one account is consistently used for fuel. This situation in 2015 resulted in a lower quantity of fuel delivered during BOXTOP, yet the costs remained unchanged and the fuel was eventually delivered.[89]

The total 2015 BOXTOP costs increased over the 2014 total of $4,527,848.35 to $5,041,428.70; an upturn of just over 10%. It is difficult to analyse trends in the costs of BOXTOP over time as the data itself is often incomplete with respect to the reasons behind why a

[87] Major B. Harbour, *Op BOXTOP - 09 OCT SITREP* (Thule AB, Greenland: 8 Wing Trenton, [2015]).
[88] . *Op BOXTOP 02/15 SITREP NO 11, 090000Z OCT 15 TO 092359Z OCT 15*
[89] Stewart, *Re: BOXTOP Costs- 12:21*

BOXTOP costs more or less than another one. As stated, these vary for a diverse set of reasons including planned construction, weather conditions, fuel required, etc. Yet, there still remains a baseline of required supplies and for rough business planning purposes the RCAF uses a cost of approximately 5 million dollars for BOXTOP each year.[90] It should be noted that all costs for Operation BOXTOP are captured using financial coding (a method in which to capture all expenses from a certain budget) from CJOC as the operation belongs to Commander CJOC. However, the Commander 1 CAD is acting his role as Air Component Commander for CJOC, thus everything done by 1 CAD and the RCAF in support of the operation all falls under the CJOC umbrella, even though all operational planning is done by RCAF units.[91]

Another cost of BOXTOP is the cost of moving the supplies from the Port of Montreal to Thule AB during the summer. At present, the cost of barge is an average of $550,000; though recent sealift has been on the order of $378,000. This cost also fluctuates based upon the source shipping the materiel. If an OGD is shipping equipment for an experiment, or for Environment Canada ongoing operation, both of which are common, the cost per pound is higher than if it is for a non-OGD. For OGD the cost has risen to $6.81/pound in 2015, up from $1.85/pound in 2002. For non-OGD the costs have similarly risen to $15.29/pound in 2015 from $6.20. The reason for the dramatic difference is the same as if they were to use aircraft. The costs for non-OGD are set in order to ensure that the government is competitive with the private sector and not undercutting them by providing better rates. By way of comparison, if they were able to ship via RCAF aircraft vice sealift, the costs are similar; For OGD the cost has risen to $6.18/pound in

[90] Gosselin, *Re: BOXTOP Costs*. Business planning is the method through which the Canadian Armed Forces (CAF) budgets for all costs needed to cover military operations each year. Business planning is conducted at each unit up the chain of command, eventually resulting in the CAF business plan presented to the government for approval.
[91] Canadian Joint Operations Command, *CJOC STANDING ORDER – OPERATION BOXTOP 2015 TO 2020* (Ottawa: Canadian Joint Operations Command, 2015).

2015, up from $.28/pound in 2002. For non-OGD the costs have similarly risen to $15.30/pound in 2015 from $6.20 in 2002.[92]

What these specific costs don't consider is the cost of personnel and equipment use during the operation. There are reasons that this cost is not included in the BOXTOP cost, as they are similarly not captured in any operation, however they are factored in to the RCAF annual business plan. For each aircraft fleet the RCAF plans a certain number of flying hours in the form of Yearly Flying Rate (YFR) that is to be used across all units, exercises, and operations. Therefore the personnel involved in determining the YFR for each fleet in the A5[93] Plans section of 1 CAD take in to account all flying hours each Squadron will require to accomplish their annual unit goals (training, proficiency, etc.), exercise requirements, and known operations like BOXTOP.[94] The final proposal or Total Air Resource Management (TARM) is sent by Commander (Comd) 1 CAD through Comd RCAF to the Chief of the Defence Staff (CDS) and incorporated in the total budget that the CAF asks for annually. The TARM

> …process is a Strategic Joint Staff (SJS) programme administered by the Royal Canadian Air Force (RCAF). It is a critical process for collecting all air support requests for effects (RFE), balancing against capacity, prioritizing them and ultimately allocating airpower effects to supported commanders with CDS priorities.[95]

Often, the requested amount of YFR is higher than the final governmentally approved amount, and 1 CAD must determine if a reallocation of YFR needs to occur between

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[92] George Stewart, RE: Boxtop II/15 - CFS Alert BOXTOP Sealift- 12:02, 5 January, 2016.
[93] "1 Canadian Air Division," last modified 15 September, accessed 19 April, 2016, http://www.rcaf-arc.forces.gc.ca/en/1-cdn-air-div/index.page . 1 CAD is organized under a modified Continental Staff methodology. Each of the major sections is designated a number based on that used by most NATO countries and generally attributed to Napoleon. The RCAF uses A rather that G or S that is most common in the Army, or the J, which signifies a Joint command. The system is broken down at 1 CAD as follows: 1- personnel, 2- Intelligence, 3- Operations, 4-Logistics/Maintenance, 5-Plans, 6-Technical Services, 7-Training, 8-Comptroller.
[94] Royal Canadian Air Force, *Total Air Resource Management Apportionment Plan FY 15/16* (Ottawa, ON: Royal Canadian Air Force, 2015), 25.
[95] Ibid., 3.

fleets in order to ensure the best balance of training, proficiency, and exercise/operation allocations.[96]

The cost per hour of flying for aircraft fleet is well-established, but it does change annually due to such variables as fuel costs, those occasions when new support contracts come into effect, exchange rate with the US, etc. The latest Cost Factors Manual outlines all of the current RCAF fleets, as well as Army and Navy assets, and breaks down those costs. There are different costs/hour depending on who is using RCAF aircraft; expressed as Total Operating Costs and Full Costs. Total Operating Costs are used when calculating the recovery of costs from Other Government Departments (OGD) and take into account that due to the fact that they are government departments, they are conducting their business on behalf of the government of Canada, and therefore such costs as aircrew and maintenance personnel, amortization, operation and maintenance, and other costs are not taken into account. When Full Costs are calculated they incorporate those costs noted above in order to more accurately compare competing options such as the civilian contracting of airlift vice using RCAF aircraft. This type of use arises in a wide variety of requests to the RCAF. They can be as diverse as a non-military MEDEVAC using RCAF aircraft vice contracting a civilian MEDEVAC company, the movement of elephants by the Toronto Zoo, and the movement of supplies by a non-governmental aid agency for humanitarian assistance.

In order to determine more accurate costs for Operation BOXTOP, the cost/hour to operate the aircraft as well as the number of hours used by each airframe are listed below. During BOXTOP, the YFR costs break down as follows:

[96] Each fleet costs a different amount per hour of flying, thus if large aircraft like the CC-177 or CC130J can use less hours than allocated, it actually means a proportionally greater number of hours to aircraft like the CH-146 Griffon helicopter. This is possible due to the government approving a dollar figure for the total YFR vice an assigned amount/fleet.

Table 2.1 – Operation BOXTOP Total Costs and Total Hour Flown

		YEARS									
RCAF Fleet	**Cost/hour**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**
CC-130H	$13,350						129.1	253.8	271.3	64.1	87.3
CC-130J	$20,750	203.3	270.5	438.9	534.3	270					
CC-177	$21,350	154.5	147.9	94	44.3	36.2	72.8	31	55	27	
CC-150	$17,150	28.9	28.6	29.1	37.5	40.6	19	47.7	92.1	43	39.9
Total hours		386.7	447	562	616.1	346.8	220.9	332.5	418.4	134.1	127.2

Sources: Captain D. Gosselin, "Boxtop YFR" (YFR Spreadsheet, 8 Wing Operations, Astra, ON, 2016a). Government of Canada, *Cost Factors Manual 2014-2015*, Vol. II- Equipment and Facility Costs (Ottawa, ON: DND, 2014a).

Therefore, including the aforementioned 2015 BOXTOP costs of $5,041,428.70, the YFR used increases the costs to $10,449,422.70.[97] While there is a $5 million planning consideration for BOXTOP as previously mentioned, there are also YFR costs that are planned ahead of time, as history has proven a good guideline for how many sorties it will take to complete the op. However, the required YFR is more likely to need adjustment based upon the needs of the Station for the year.

The end result of this is that for every hour that the CC-130J or CC-177 do not have to fly in support of Operation BOXTOP, it allows the RCAF a credit in the form of YFR. This credit is not true savings in terms of a standard fiscal consideration, but one in which the RCAF could allocate elsewhere. This is due to that fact that there is a cap on the total budget allowed for all RCAF flying which is then determined how it will be allocated in the TARM. For the fiscal year 2015/2016, the total Unfilled Demand for RCAF aircraft was 13,854 hours. This demand was spread across seven of the 18 RCAF aircraft fleets.[98] Thus any excess, or returned YFR, can readily make up for deficiencies in other fleets. Wings and units will then use the YFR for previ-

[97] Major T. Farrell, *Op BOXTOP - 25 APR SITREP* (Thule AB, Greenland: 8 Wing Trenton, [2015]); Harbour, *Op BOXTOP - 09 OCT SITREP*.
[98] Royal Canadian Air Force, *Total Air Resource Management Apportionment Plan FY 15/16*, 25, 6.

ously unfunded or unforeseen flying in other exercises, operations, and the associated additional training for aircrews.[99]

Another factor in cost savings to the RCAF if reductions in YFR are realized can be found in the form of personnel who are away from the primary job for the 3 weeks of each operation. These costs do not really equate to money saved in the same manner in which costs are broken down as outlined previously as each military member is paid a salary regardless of where they are working.[100] The costs associated with the temporary duty including food, per diem, hotel, etc. are already captured within the BOXTOP costs and their specific savings potential per day have already be stated. What are not captured are the unmeasurable costs of personnel being away from families, the impact of repeated deployments on the member, hardship on units who have to take up the slack for deployed members, etc. In fact, studies have shown that the more that military parents are away, the more direct impact not only on the military members, but their families as well. This can be seen in higher divorce rates, developmental problems for children of absentee parents due to multiple deployments as well as the increase possibility of abuse and/or neglect of their children, and mental health issues for family members.[101] These studies were normally focussed on longer deployments to combat theatres, but many of the issues of a military parent being away still apply as the cumulative effects of being separated. It is acknowledged that BOXTOP is a relatively short operation, but as 8 Wing Trenton are the main supporters of the operation, it is often the same personnel that continually deploy on BOXTOP and other

[99] Ibid., 7.
[100] Government of Canada, *Cost Factors Manual FY 2015-2016: Estimated Full Costs for FY 2015-2016*, Vol. I- Personnel Costs (Ottawa, ON: DND, 2014), 3.
[101] Alicia Gill Rossiter, Rita D'Aoust and Micheala R. Shafer, "Military Serving at what Cost? the Effects of Parental Service on the Well-being of our Youngest Military Members," *Annual Review of Nursing Research* 34 (2016), 109.

global air mobility operations, thus creating a greater effect than simply that of the Alert sustainment.

The bottom line when it comes to personnel is that while all members know that they will have to be away from family and their primary workplace at times, if the necessary times are able to be limited, it makes the work more palatable to the member and their families, which can lead to a better work/life balance and may see benefits in the retention of personnel; always a problem in units with higher operational tempo. While these costs are truly difficult to calculate, they should not be overlooked or ignored.

Costs come in a variety of forms in military operations. For Operation BOXTOP, some of those costs are explicit such as the annual planning costs and the YFR. Other costs remain difficult to quantify, yet have a direct impact on the manner and ability in which the RCAF conducts operations. Mitigation, proper planning, and creative solutions to existing problems are the ways in which the RCAF will realize the most savings.

Operational Options for Cost Reductions to Operation BOXTOP

There are a number of options that can be immediately implemented that will improve the way in which CFS Alert is sustained and thus reduce reliance on BOXTOP. One of the most important is a dedication to ensuring that each sustainment flight maximizes use of cargo space. From the authors' experience, there were many times that aircraft arrive with space available for supplies with commensurate fuel aboard, effectively wasting JP-8 that could provide cost savings during Operation BOXTOP by reducing the required number of sorties.

Effective cargo management on this scale would likely require more dedicated storage space 8 Wing Trenton, and the benefits would be realized through proper Station inventory management over time. The intent being that more supplies could be purchased ahead of time for

Alert and then warehoused at 8 Wing, which due to the infrastructure of the Wing would prove little challenge. A relatively small stock could then be used to take advantage of space as it became available on flights.

In order to maximize the potential of this recommendation, one Lieutenant/Captain could be assigned as the Alert Officer of Primary Interest (OPI) as a secondary duty at 2 Air Movement Squadron at 8 Wing. This would allow the OPI to be the single point of contact for the Station, Alert Management Office (AMO), Construction Engineering (CE), etc., and would be better positioned to maximize the load for each aircraft, especially given the many last minute changes. Even if this were a six month duty, it would provide much needed oversight and assistance. At the moment there is no single point of contact at 2 Air Movements Squadron and thus any advantage to be gained by the flexibility found by empty cargo space on a CC-130 or CC-177 is lost, as no single person is responsible for ensuring max loads. At the moment, there is a very effective system in place at 2 Air Movement Squadron that ensures a duty crew is always available to cover all Air Mobility cargo arriving and departing 8 Wing. In large part due to the nature of shift work, these Traffic Techs don't have situational awareness and direction/oversight on specific, ongoing, and immediate requirements for Alert, and thus are not in a position to take advantage of the space available. Additionally, they have any number of other sorties that also have to be loaded, and the most efficient method for ensuring success on a large volume of cargo is to ensure that there is little deviation or thought required into each load at their level.

If there were an Alert OPI for the management of cargo, it can reasonably be expected that fewer items would have to be shipped to Montreal to be barged to Thule and thus flown in during fall BOXTOP; reducing costs to the RCAF by eliminating some of the shipping and/or required sea and airlift. Exact cost savings would be difficult to estimate, as 2 Air Movement

Squadron, AMO, and Alert were uncertain of the average weight of the cargo that could conceivably be put aboard each week. This approach would also enable more purchasing just-in-time for dry goods and construction material that is otherwise purchased in May and June for shipment to the Port of Montreal in time for the barge in July.[102]

Focused use of Weekly Service Flights and use of the CC-177 Globemaster III

Better fuel management during sustainment flight would see immediate cost savings and further reduce reliance on BOXTOP. Currently, the plan for each CC-130 sustainment flight is a three-day cycle which sees the aircraft fly to Thule and remain overnight, upload fuel and fly to Alert in order to offload and upload all passengers and cargo. Upon departure they return to Thule and remain overnight once more. The plan for the CC-177 is a two day cycle, due to its larger fuel capacity, greater speed and range (compared to either CC-130 model) is to have the aircraft fly direct to Alert to offload passengers and cargo and upload the outgoing. Upon departure, they fly to Thule to remain overnight, refuel, and return to 8 Wing.[103]

During their time on the ground at Alert, CC-130J and CC-177 will also offload what fuel they can into whichever of the Station's fuel systems (JP-8 or DF-8) require it. The CC-130J offloads and average of approximately 2,800 litres and the average CC-177 offload is 50,000 litres per sustainment flight. If we assume a 3:1 ratio for CC-130J flights per month, which is traditionally the case, CFS Alert receives approximately 58,400 litres of fuel per month.[104] 2014 spring BOXTOP planned and delivered 1,400,000 litres and fall BOXTOP planned and delivered 750,000 litres. By contrast, 2015 spring BOXTOP planned 1,400,000 litres but was only able to

[102] Stewart, *RE: Boxtop II/15 - CFS Alert BOXTOP Sealift- 12:02*
[103] Captain K. Mulkins, RE: CC-130J and CC-177 Lines of Tasking- 13:37, 2 February 2016, 2016.
[104] Ibid.

deliver 955,074 litres and fall BOXTOP planned 1,300,000 litres but due to maintenance problems was only able to deliver 445,400 litres.[105]

Based on these numbers, in an examination of the number of sustainment flights that would be required in order to deliver the complete 2015 total of 2,700,000 litres of fuel using CC-177 only at 50,000 litres per offload, it would take 54 sustainment flights. The CC-177 plans for 15 YFR per sustainment flight, thus approximately 810 hours.[106]

Currently the TARM does not explicitly list Operation BOXTOP as it is an ongoing mission vice both Operation REASSURANCE (Canadian commitment to Eastern Europe) and Operation IMPACT (Middle East operations) which are funded operations.[107] It should be noted that the total Force Employment (FE), which are operational hours vice training hours, approved for the CAF is 1994. This includes 840 hours for Operation IMPACT, only 36 hours for Operation REASSURANCE and an additional 75 hours for Operation IGNITION (NATO air patrol of Iceland). This leaves only 1043 hours for the remained of all CAF CC-177 operations including the normal amount planned for BOXTOP. CJOC was allocated 1031 hours of the remainder for all of its operations, to including BOXTOP. Therefore we can see that the math simply would not work out given the current YFR.[108]

However, there is a method which could produce results without the significant YFR issues outlined above. If the CC-177 were to increase each sortie by one extra day to add another full fuel offload in Alert, it would allow 105,000 litres per sortie to be offloaded vice the current

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[105] . *Op BOXTOP 01/15 SITREP- Final, 250800Z APR 15*. *Op BOXTOP 02/15 SITREP NO 11, 090000Z OCT 15 TO 092359Z OCT 15*

[106] Ibid. Based on the information provided above on fuel totals and planned YFR per sustainment flight, along with the given offload capability of the CC-177, 2,700,000 was divided by 50,000 to provide the 54 flights. As each flight is allotted 15 hours, a multiplication of that and the 54 flights provides 810 hours total.

[107] National Defence and the Canadian Armed Forces, "Operation IMPACT," last modified 02 May 2016, http://www.forces.gc.ca/en/operations-abroad-current/op-impact.page National Defence and the Canadian Armed Forces, "Operation REASSURANCE," last modified 02 May 2016, http://www.forces.gc.ca/en/operations-abroad/nato-ee.page

[108] Royal Canadian Air Force, *Total Air Resource Management Apportionment Plan FY 15/16*, 25, 6-7.

50,000 litres, and would reduce the required sorties from 54 to 26 (rounded up), or approximately 390 flying hours vice 810 for the full annual fuel requirement.[109]

More savings could be realized if two sorties were used on each additional day (due to distance from Thule to Alert, the aircrews would not reach maximum duty day)[110], thereby reducing required missions to 13, which is much closer to the number of sustainment flight CC-177 fly to CFS Alert each year.[111] This would not add a tremendous strain on the fleet and 429 Squadron personnel: only an extra day per sortie. While cost per sustainment flight would increase, the associated costs for Operation BOXTOP would drop and more than make up for the offset. Currently BOXTOP moves the required amount of fuel in approximately 95 hours over the two BOXTOP periods, but the costs for increasing each sortie by one day would be approximately 2.7 YFR each for a total cost to CC-177 Yearly YFR of 70.2 hours.[112]

Overall, this approach could help eliminate the requirement for most of the fuel to be delivered during BOXTOP and the operation could then focus on the remainder of the sustainment with fewer aircraft, crews, and costs, and could be complete within a week in both spring and fall. The ULSD would still have to be flown in along with the dry goods, construction materials,

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[109] "Royal Canadian Air Force Aircraft," last modified 19 August, accessed 28 February, 2016, http://www.rcaf-arc.forces.gc.ca/en/aircraft.page. George Stewart, FW: Boxtop II/15 - CFS Alert Boxtop SeaLift- 13:08, 26 January, 2015. Based on the information provided by George Stewart fuel totals along with the data on max useable fuel of the CC-177 and personal experience as CO CFS Alert during Op BOXTOP, the total fuel the CC-177 can carry on this type sortie is 105,000 litres and maintain safe fuel for RTB Thule and the required emergency fuel. The required 2,700,000 litres a year was divided by 105,000 litres per flight to provide the 26 flights. As each flight is allotted 15 hours, a multiplication of that and the 26 flights provides 390 hours total.

[110] Royal Canadian Air Force, *Flight Operations Manual- Effective 0001Z 21 Mar 2016 to 0000Z 21 June 2016* (Winnipeg, MB: 1 Canadian Air Division, 2016), 1044.

[111] This may be difficult goal to achieve due to the very high demand for the CC-177 and its role as a strategic asset. While the proposal would have likely been untenable when the RCAF had only four CC-177's in its inventory, with the recent addition of the fifth airframe, this is a more reasonable recommendation. The bottom line for the RCAF is where it can achieve the greatest impact and cost benefits; dramatic reduction in the need for BOXTOP and all related costs, or use in global operations, reducing reliance on the CC-130J.

[112] Major S. G. Marshall, *Briefing Note for Comd 1 CAD- Op BOXTOP COA Recommendations* (CFS Alert, NU, 2015). This calculation takes the data from the previous paragraph and divides it by two to result in 13 hours needed. The YFR provided is derived from the referenced Briefing Note, and the 2.7 hours is multiplied by the 26 sorties. Note that although it states only 13 missions would be required; it still required 26 sorties as a second once is added during the overall sustainment flight.

etc., but with such a dramatic decrease on fuel requirements, even if it were only partially implemented so as to continue to take advantage of the required BOXTOP flights, the YFR and associated TD cost savings would be substantial.

Other Cost Reduction Options

There have been a number of examinations in the past of possible ways in which to eliminate or reduce BOXTOP, and were usually the result of other operational commitments and the fiscal and YFR constraints they presented. This has been even more prevalent an issue since the acquisition of the CC-177. In 2015, there was a concerted look at eliminating the spring BOXTOP but two issues arose that could not be overcome. Based upon the measured usable volume on hand of domestic fuel (in this case both JP-8 and DF-8 are combined) of 968,000 litres minus the emergency fuel threshold of 450,000 litres left and actual useable volume of 578,000 litres. Due to a forecast use of 787,690 litres from January - April 2015, it left a shortfall of 209,960 litres. April to October had a planned usage of 933,571 litres, which would have sustained them to the next planned BOXTOP, and would left a total shortfall of 1,143,531 litres.[113] While it was acknowledged that some of that shortfall could have been made up during sustainment flights under the current methodology, the reasoning behind the request as that Operation IMPACT and other global air mobility operations were ongoing and there was an examination of whether they could cancel that BOXTOP in order to reallocate the CC-177 and CC-130J YFR to operations elsewhere and what the impacts would be. 8 Wing was able to determine (and 1 CAD agreed) that the final numbers did "not benefit us in the least to do away with the spring boxtop (*sic*) in terms of money (an [Air Task Force][114] is cheaper than the additional YFR hrs spent) or

[113] Stewart, *FW: Boxtop II/15 - CFS Alert Boxtop SeaLift- 13:08*

[114] Royal Canadian Air Force, *B-GA-400-000/FP-000 Canadian Armed Forces Air Doctrine* (Ottawa, ON: National Defence, 2016). The Air Task Force (ATF) is a new operational concept that allows for the organization of air assets under a designated air task force commander to a Force Employer. They may be employed at an operational or tacti-

hours".[115] What was decided was that due to such a dramatic fuel shortfall, the YFR required in order to mitigate or eliminate it would be far too costly and would thus essentially eliminate most of the benefit realized from cancelling spring BOXTOP. If the possibility of fuel shortfalls had been known further ahead of time, there is a possibility that a plan to overcome the shortfalls could have been developed and implemented in time to mitigate, but they were not.

As is the case with most aspects of sustainment operations in Alert and the Arctic writ large, if there is a plan in place ahead of time, there is a greater possibility that that plan will succeed. Once there is a significant deviation from an established sustainment plan for such an isolated location, operations are put at risk along with those personnel deployed to ensure mission success of the Station.

Infrastructure

The construction of new infrastructure is another way in which Operation BOXTOP could be eliminated. Currently there are no hangars with which to house aircraft, necessitating some creative solutions for sustainment flights, maintenance issues, and using Thule as a support hub. There are a few different approaches that could be undertaken at Alert which would improve its operational flexibility, but any cost savings that arose from what would be the virtual elimination of BOXTOP would invariably take years to realize.

The construction of a hangar able to house the CC-177 would be the quickest and likely most effective approach to reduce or eliminate BOXTOP. It would allow for the overnighting of CC-177 at Alert, which is currently restricted from doing so in order to mitigate the potential for maintenance breakdowns as well as extended weather impacts. The Globemaster currently stays

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cal level, but as a minimum will include and ATF Headquarters and mission support element. It allows for a plug-and-play approach to operations, giving the Task Force Commander a complete ATF and all of its assets under an established Command and Control Architecture. The ATF construct is now used on every operation involving the RCAF; most recently in Operations REASSURANCE and IMPACT, but is also used for BOXTOP.

[115] Captain N. L. Graham, Re: Boxtop II/15 - CFS Alert Boxtop SeaLift- 08:54, 15 February, 2015.

on the ground only as long as absolutely required. There is only one known instance in which the CC-177 remained overnight; during the Change-of-Command in January 2015 during which time His Excellency the Governor General was visiting the Station. It remained due to the concerns outlined above as well as the standard precautions taken for His Excellency in the Arctic. Even so, with wind chills below -55^{o} Celsius, the aircrew remained concerned that the aircraft would have trouble starting and that any ice that had built up on the horizontal surfaces would be exceedingly challenging to remove; Alert has limited de-icing and anti-icing capabilities, and the equipment does not reach the horizontal stabilizer on the Globemaster at 55 feet above ground.[116]

Construction of a hangar would allow direct flights for the CC-177 and a place to overnight for any aircrews. It is likely that such a hangar could result in eradicating the requirement for shipment of dry goods to Thule AB, thus eliminating the majority of the need for USAF support, except in situations where the aircrew must divert for weather considerations, or in emergency situations.

Other benefits that such construction would realize are the dramatically improved ability to conduct Arctic sovereignty operations from the Station. Currently there are only NORAD Forward Operations Locations in Inuvik, Yellowknife, and Iqaluit.[117] While the CF-188s would be incapable of landing on Alert's gravel runway, other sovereignty operations could still take place. The year 2012 saw the first CH-149 Cormorant visit the Station on its return from Operation NANOOK to 9 Wing Gander and during the summer of 2014 the first Arctic deployment of the RCAF's new CH-147F Chinook took place. This exercise showed the ability of RCAF rotary-wing assets to operate in the High Arctic, potentially even outside the summer season. It

[116] Royal Canadian Air Force, "Royal Canadian Air Force Aircraft," last modified 19 August 2015, http://www.rcaf-arc.forces.gc.ca/en/aircraft.page
[117] Royal Canadian Air Force, "Wings and Squadrons," last modified 20 November 2015, http://www.rcaf-arc.forces.gc.ca/en/wings-squadrons.page

would create a suitable hub for other helicopter operations as well. This extends the possibility of High Arctic Search and Rescue operations, especially with the forecast melting of the polar ice cap and the associated likelihood of Artic shipping lanes opening as well as Arctic tourism on cruise ships.[118] This increase in Arctic tourism is especially concerning for those involved in SAR, and for the vice commandant of the U.S. Coast Guard, it is especially concerning. "This keeps me up at night…a rescue would be a very complex operation. It's a very difficult area with difficult weather."[119]

The drawback to construction of a hangar is fraught with challenges, long timelines, and high costs. First, actual construction in the Arctic uses the rule-of-thumb that any construction will take at least twice as long as what it would take in the south. Thus when the construction of even a modest hangar may take 5-6 years, it is likely to take 8-10 as aside from a shortened construction season, all supplies must be flown in.[120] Estimated costs from 1 CAD A4 Construction Engineering section provide an estimated range for a hangar (based upon a 2012 examination for a hangar at Resolute that can house a CC-177 from an austere hangar at $54,000,000 up to a robust maintenance hangar at $100,000,000 (with inflation to 2016 it ranges from 56,628,712.87 - $104,867,986.80).[121] These costs included design, construction, project management and contingencies but are not all inclusive. The additional shipping costs associated with Alert as this was an examination for Resolute. [122]

While the construction of a hangar would provide immediate benefit to the Station, its operations as well as Arctic sovereignty ops, an associated runway improvement is unlikely to be

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[118] Poitras, *Search and Rescue in the Arctic: Myth Or Reality?*. 55-58.
[119] Joel K. Bourne Jr., "Cold Rush," *National Geographic*, March, 2016.
[120] Major J. Martin, RE: JCSP Research Paper- 10:49, 20 April, 2016.
[121] "Inflation Calculator," accessed 20 April, 2016, http://www.bankofcanada.ca/rates/related/inflation-calculator/ . 1 CAD 2012 data was input and 2016 selected for current estimated pricing as recommended by Major J. Martin from 1 CAD A4 CE.
[122] Martin, *RE: JCSP Research Paper- 10:49*,

feasible. As it stands, aside from similar time delays and costs as outlined above, the conditions that far in the Arctic does not support the construction of suitable runways. Alert is gravel and must have runway crews in for repair each summer due to compacting and sinking, frost and cold related issues, and it is unlikely that given current runway construction technology that it could conceivably be overcome. Alert also sits at 100 feet above Mean Sea Level and sits on a depression on a peninsula. None of which contribute to conditions not appropriate for a paved runway.[123]

The other consideration for Alert could be the construction of a pier in order to allow for the direct offloading of supplies from barges direct from the Port of Montreal to Alert. While this is not feasible at the moment due to ice coverage at Alert, in the Robeson Channel between Ellesmere Island and Greenland, as well as further south. However, this option should not be discounted for future planning considerations, as Mr. Bob Ferguson, an engineer with ADM(IE) Real Property Operations in Halifax suggests that this option could be built at an estimated cost of $20,000,000.[124] While the length of time to construct it would be years longer than one constructed most anywhere else in Canada, given the environment and challenges with the Lincoln Sea, the benefit could see barges able to depart the Port of Montreal and arrive at CFS Alert, thus essentially eliminating reliance on Thule for that aspect of sustainment.

Conclusion

In any situation where the construction of a capital project is being recommended and/or considered, especially for Alert, a number of governmental and CAF partners need to be consulted. In this case, the future of CFS Alert and its' SIGINT mission need to be considered by not

[123] NAV CANADA, *Flight Supplement Canada and North Atlantic Terminal and Enroute Data: Department of National Defence Flip GPH 205-*, Vol. Effective 0901z 31 March 2016 to 0901z 26 May 2016 (Ottawa, ON: NAV CANADA, 2016), B11.
[124] Bob Ferguson, RE: JCSP Research Paper, 5 May, 2016.

only the RCAF, but CFIOG, ADM(IM), as well as CSE in order to develop a construction plan that makes sense for future mission of the Station.

There are a multitude of options that would produce tangible results in eliminating the need to Operation BOXTOP. The operational and infrastructure recommendations in this chapter provide a potential roadmap to reducing those goals, with those associated with flying operations producing much greater effect at lower cost. The examination of the construction of new infrastructure at CFS Alert is a possible benefit in the long term to Arctic Sovereignty operations, yet the cost benefit actualization reduces these to more fanciful options.

Operational and infrastructure recommendation are not the only potential efficiencies that may be found at Alert. Chapter 4 will examine some creative alternatives to these options and provide concrete cost savings that may be realized through their implementation.

OTHER ALTERNATIVES

Introduction

In addition to the operational options examined in the previous chapter to reduce the costs of Operation BOXTOP, there are other alternatives that merit examination. The use of alternative Canadian airfields has long been discussed as a potential alternative sustainment HUB to Thule AB. The use of commercial airlift has been conducted at various times throughout the history of Alert, and may prove to be a suitable method to reduce costs and YFR for the RCAF. Defence Research and Development Canada (DRDC), in conjunction with Natural Resources Canada (NRC) conducted an exhaustive study on energy saving measures at Alert which, if implemented, would see drastic cost and YFR savings. Finally, there are seemingly small-ticket items like inventory control and changes to the purchase and shipment of rations that can be explored. Regardless of the method, these alternatives provide tangible ways the RCAF can save money.

Alternatives to Thule AB for CFS Alert Sustainment

In the past there have been discussions and examinations as to the potential use of Canadian airfields as a BOXTOP hub vice the continued use Thule AB. This would essentially entail creating an Operational Support Hub concept similar to that in Kuwait for Middle East operations.[125] There are a number of potential benefits to the possibility of such a plan; however there are also a number of drawbacks that may not make it feasible. Realistically there are very few choices for use of existing Canadian arctic airfields that already have some sort of infrastructure and support capability; they include Iqaluit and Resolute, which are both located in Nunavut. However, even these two airfields would require capital investment in order to be able to provide the level of service that Thule AB currently provides.[126]

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[125] Ziprick, *Leveraging Air Mobility to Support Canadian Arctic Sovereignty*, Chapter 4.
[126] Thule AB, *Welcome to Thule "the Top of the World"* (Thule AB, Greenland: Thule AB.

One of the benefits to the consideration of such an option is the follow-on effects that such presence would provide to local communities. Investments in Hubs would be a much-needed, dramatic boost to the economies of small communities in the form of good and services, the associated "tourism" benefits (purchasing food, supplies, and souvenirs, as well as hiring guides), as well as training, in a place where "a third of Nunavut's population of 40,000 doesn't get enough to eat."[127] It would likely provide seasonal work with a possibility of more, in communities where unemployment can be up to 30% is not uncommon.[128] With improvements in either location, a Whole of Government approach could be taken towards the facilities, and it is likely that many effects from those departments would have positive impacts on the local economies as well as that experienced from the CAF alone.[129]

Resolute is the current location of the CAF Arctic Training Centre. It has some storage capability on site to house some of the materials needed during BOXTOP. The facility currently has 1100 square feet of space, but much of that is normally taken up by the equipment used by the Arctic Training Centre as well as Natural Resources Canada, which shares the facility. It also has the ability to house up to 140 personnel as well as dining and recreation facilities, meaning little would be required in terms of housing from the tiny community.[130] However, there are a number of drawbacks to what at first glance may appear to be a suitable option.

Resolute is a very small hamlet of only 242 people located on Cornwallis Island, well into the Arctic Archipelago. While there exists a rich archeological record of Inuit and proto-Inuit peoples, it is one of the communities created in the "1953 High Arctic relocation on Inuit people

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[127] Bourne Jr., *Cold Rush*, 12.
[128] Ibid.
[129] Government of Canada, *Canada's Northern Strategy: Our North, our Heritage, our Future.* (Ottawa, ON: Government of Canada, [2009]). Government of Canada, *Statement on Canada's Arctic Foreign Policy: Exercising Sovereignty and Promoting Canada's Northern Strategy Abroad* (Ottawa, ON: Government of Canada, [2010]). Department of National Defence, *Canada First Defence Strategy* (Ottawa: Government of Canada, 2008).
[130] "Canadian Armed Forces Arctic Training Centre," last modified 27 August, accessed 17 April, 2016, http://www.forces.gc.ca/en/news/article.page?doc=canadian-armed-forces-arctic-training-centre/hkdons6l

by the Government of Canada during the Cold War," created in the hopes of bolstering Arctic sovereignty.[131] Because of its size and location, all food, supplies, and fuel have to be flown or shipped in (difficult due to ice coverage and its location in the Northwest Passage) and cannot be purchased on the economy. Shipment of materiel via ship or barge to Resolute via the Port of Montreal is feasible, but there is no guarantee that it will make it to the community in time for operations. The summer season of mid-June to September is still considered excellent snowmobiling conditions, by which we infer ongoing excellent snow and ice conditions, thus reducing the possibility of sustainment arriving by ship.[132] Additionally, there is no hangar space at Resolute, or sufficient warehousing space for all of the BOXTOP materiel to be stored awaiting the spring and fall operations. Such infrastructure be considered a necessity due to Resolute's latitude, and would therefore be required in order to support Alert like Thule. Due to the volume of fuel required for Alert sustainment, the fuel farm currently in place would have to be expanded dramatically. Finally, while CAF members are assigned to the training centre at certain times of the year, no members are posted there year round, which could reasonably be expected to amplify issues associated with the receipt of materiel, its warehousing, and support for the expanded centre. Therefore, while the use of Resolute is possible, it is not currently feasible and would require substantial investments in terms of infrastructure. That investment would see dramatically increased capabilities of the Arctic Training Centre for its mission for training CAF personnel, and would provide a secondary effect of enhancing the capability for sovereignty operations, as well as brining much needed money into the community, but would do little for Alert sustainment.[133]

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[131] "Resolute," , accessed 17 April, 2016, http://nunavuttourism.com/regions-communities/resolute
[132] Ibid.
[133] David Pugliese, "Canadian Forces to Expand Nunavut Training Centre as Russia Plans More Bases in the Arctic," *National Post*, sec. Politics, 23 February, 2016.

The other possible community in which BOXTOP operations could occur is Iqaluit, located on Frobisher Bay, Baffin Island. There are a number of reasons why Iqaluit appears to be a better option than Resolute. The town was created during the Second World War by the USAF at the head of Frobisher Bay in 1942-1943.[134] With the move of a nearby Hudson's Bay Trading post to the apex of Frobisher Bay in 1948, it attracted many Inuit families who established residence in what would become the town of Iqaluit.[135] The airfield has been maintained since that time and it is currently the location of a North American Aerospace Defence Command (NORAD) Forward Operating Location (FOL) attached to the civilian airfield.[136] Lieutenant-Colonel John St. Denis, a former Chief of Staff for Joint Task Force North believes that the idea has merit. "The airport had already been identified in the [CJOC] plan for the North as being one of the primary Arctic Hubs" St. Denis notes, "so aligning BOXTOP with these plans would tie very nicely to what the Canadian Forces (*sic*) are doing there."[137] While the FOL does not contain a hangar big enough for either the CC-130J or CC-177, it does have a building which can house and feed 120 personnel. The community is much bigger than Resolute, with a population of 7,250. In addition, as Iqaluit is the capital of Nunavut and an Arctic tourism hub, options exist in the community for housing and feeding of personnel should the current FOL prove insufficient.[138]

The use of Iqaluit also has a number of drawbacks which detract from its potential, however. As Heidt and Goette note, "Thule sells JP-8 jet fuel to Canada at an extremely good price…and [so] purchasing the equivalent fuel from Iqaluit would be much more expensive."[139]

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[134] Robert V. Eno, "Crystal Two: The Origin of Iqaluit," *Arctic* 56, no. 1 (March, 2003), 63.
[135] Ibid., 73.
[136] "Training Together to Better Protect the North," last modified 30 October, accessed 19 April, 2016, http://www.norad.mil/Newsroom/tabid/3170/Article/626808/training-together-to-better-protect-the-north.aspx
[137] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 318.
[138] "Iqaluit," , accessed 17 April, 2016, http://nunavuttourism.com/regions-communities/iqaluit
[139] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 318.

Iqaluit does not have a port for the offload of materiel from ships, even though it is far more accessible than Resolute due to its geographic location. That is not to say that ships to do not go to Iqaluit, but simply that they currently have to offload in very makeshift methods which can vary from the ice directly adjacent a ship, tractors, ad hoc docks which are purpose built, etc. One of the issues with shipping in Frobisher Bay is that the bay has insufficient depth with which ships need in order to get close to town for offloading and thus a pier has never been built (see costs on CFS Alert pier construction for similar issues associated with the construction thereof).[140] As a consequence, most supplies are flown in. This also contributes to early freeze up of Frobisher Bay, which can end the shipping season before completion. This was the case in 2015 when the MV *Umiavut* was unable to complete delivery. Significantly, the ship's operators stated that "the incomplete delivery would not have happened if Iqaluit had a port."[141]

Finally, while four CAF personnel are posted to Iqaluit, their numbers would have to be increased in order to provide the support needed for expanded facilities; thereby further increasing costs.[142] George Stewart, the 30+ year steward of all Alert sustainment operations and the driving force behind BOXTOP expressed his doubts "that the town could accommodate the sheer number of personnel required for [BOXTOP] operations."[143] While at first examination Iqaluit may seem a suitable location due to size and geographic location, it would also need far too much investment in order to bring it to a level nearing what Thule can and has historically provided.

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[140] Bob Ferguson, JCSP Research Paper, 5 May, 2016. The jetty at Nanisivk, NU began as a $100 million, and ballooned to $250 million with scope creep, and as Iqaluit does not have an existing pier, that number would not likely be far off.
[141] "Ice Prevents Iqaluit's Last Sealift Ship from Offloading its Cargo," CBC, last modified 30 October, accessed 19 April, 2016, http://www.cbc.ca/news/canada/north/ice-prevents-iqaluit-s-last-sealift-ship-from-offloading-all-its-cargo-1.3297748
[142] Heidt and Goette, *This is no 'Milk Run': Operation BOXTOP, 1956-2015*, 318.
[143] Ibid., 318.

While there exist some options which, through substantial capital investments could be feasible, neither airfield at neither Resolute nor Iqaluit is without serious flaws. While Iqaluit would be a better option, as Lieutenant-Colonel Kyle Paul, CO of the Canadian Detachment at the Northeastern Air Defense Sector in Rome, NY, noted during large NORAD exercises "the professionalism and dedication of all participants…made it possible to circumvent all the challenges associated to the deployment of such a task force."[144] The same could be true for similar efforts to utilize Iqaluit for Operation BOXTOP. Perhaps no clearer thoughts need be expressed when considering the status quo versus changes to Alert sustainment ops away from Thule to Canadian airfields. Thule AB has the hangar space, pier, warehousing, housing, feeding, and fuel farms needed to support Alert throughout the year, as BOXTOP operations over the years have proven. Nowhere else in the Arctic comes close to providing the services needed.[145] Perhaps in the future under a Whole of Government approach to the Arctic, the cost that would currently need to borne exclusively by the CAF could be spread across multiple government departments, thus reducing the financial burden on the CAF that such undertakings would require.

Commercial Airlift

While utilization and location of Arctic airfields has been a concern since before the founding of Alert, one way in which it could be mitigated is through the use of contracted airlift and could be examined to determine cost benefits for Operation BOXTOP. By shipping more supplies via truck or rail, and combinations thereof (vice barge to Thule), to places such as Yellowknife, contractors could fly in more products at potentially lower cost than by barge.[146] How-

[144] North American Aerospace Defense Command, *Training Together to Better Protect the North*, http://www.norad.mil/Newsroom/tabid/3170/Article/626808/training-together-to-better-protect-the-north.aspx
[145] Thule AB, *Welcome to Thule "the Top of the World"*
[146] Chemistry Consulting Group, *City of Yellowknife 2015-2019 Tourism Strategy Background Report* (Yellowknife, NWT: City of Yellowknife, [2014]).

ever, cost savings would likely be seen more for YFR and associated costs for RCAF aircrews and ground crews similar to those outlined in Chapter 3.

One aspect of sustainment BOXTOP operations where contracted airlift could best be employed is for Ultra Low Sulphur Diesel (ULSD) delivery. Currently one CC-130 is dedicated to flying between CFS Alert and Resolute for ULSD during wet BOXTOP. This fuel is currently barged to Resolute; increasing the costs to the CAF and the possibility of non-delivery due to ice. If contracted fuel deliveries were to be spread throughout the year, similar to what was discussed regarding CC-177 use during weekly service flights, taking into account the planned annual 300,000 litres of ULSD, it would eliminate one complete CC-130 dedicated to each BOXTOP and the associated crews, YFR, and fuel for the aircraft. Based upon the fall BOXTOP numbers for one CC-130, this would mean approximately $477,000 savings.[147] However, the cost of contracting commercial airlift in this manner does no present substantial cost savings over that number.

The last time commercial aircraft were used for Operation BOXTOP was during the fall BOXTOP in 2010 when a First Air C-130 stretch Hercules was used to transport fuel. This aircraft was not able to transfer from the wing tanks like both the RCAF CC-130J and CC-177 are capable of doing, and had to use an onboard fuel bladder. The costs at the time $384,000 baseline plus $37,000 per sortie from Thule-Alert-Thule; approximately $14,000 per hour and they carried 8,700 litres per sorties for offload. Fuel came from RCAF resources at Thule, thus there were no additional costs for the fuel.[148] This did not present significant savings over the use of the CC-130 outlined above, and so the option was not used again.

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[147] Stewart, *Re: BOXTOP Costs- 12:21*
[148] George Stewart, RE: BOXTOP Research Paper Questions- 12:16, 5 January, 2016.

Commercial aircraft have also been used for weekly sustainment flights over time when RCAF aircraft were unavailable. The cost for the flight from 8 Wing Trenton to CFS Alert via Iqaluit was $196,000 per flight. They were capable of a maximum load of 14,500 lbs when temperatures at Alert were above -10 Celsius and 16,800 lbs if they were below that number. These aircraft were often Boeing 737s from the company First Air.[149]

One of the main detractors from the possibility of once again employing commercial airlift in any type of sustainment role is the way in which companies view the operation vice how the RCAF and CAF view it. Namely, any corporation in responsible to the bottom-line, while the RCAF is based upon professionalism. The recent example of Buffalo Airways having their licence revoke by Transport Canada due to its "poor safety record" highlights an emphasis on the bottom line amongst one of the biggest Arctic charter freight companies.[150] While the RCAF is certainly not exempt from safety issues, the company exhibited a failure to consistently comply with aviation safety regulations and an adversarial relationship between the airline and Transport Canada.[151]

The future could also see some dramatic changes in airlift options that allow for more creative sustain operations for CFS Alert. These include the use of "large cargo airships that can airlift more than 20 tons operate on short runways and travel distances of 2,000 kilometres or more would eliminate Canada's reliance on foreign airbases to support our Northern outposts."[152]

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[149] Ibid. Royal Canadian Air Force, *Royal Canadian Air Force Aircraft*, http://www.rcaf-arc.forces.gc.ca/en/aircraft.page .By way of comparison the RCAF CC-177 has a max payload of 170,000 lbs and the CC-130J has a max payload of 48,000 lbs.

[150] "Buffalo Airways' Licence Reinstated by Transport Canada," CBC, last modified 12 January, accessed 4 May, 2016, http://www.cbc.ca/news/canada/north/buffalo-airways-licence-reinstated-1.3401130

[151] "Buffalo Airways, of TV's Ice Pilots NWT, has Licence Suspended," CBC, last modified 2 December, accessed 4 May, 2016, http://www.cbc.ca/news/canada/north/buffalo-airways-suspended-1.3346524

[152] Royal Canadian Air Force, *Projecting Power: Canada's Air Force 2035*, ed. Andrew B. Godefroy (Astra, ON: Canadian Forces Aerospace Warfare Centre, 2009). 11.

Recently this type of alternative thinking took huge leaps forward as Lockheed Martin and Thales both announced partnerships with companies that plan to have commercial airship capabilities available as early as 2018. The Lockheed Martin and Hybrid Enterprises hybrid airship submission was unveiled in 2015 their design for the LMH-1 Hybrid airship at the Paris Airshow in Le Bourget, France.[153] It has been in development for 20 years and focussing on delivery and sustainment operations in remote locations in which standard transportation systems and infrastructure do not exist, or would be cost prohibitive. This can be seen in small-scale mining operations in places like Africa, in which building rail would induce excessive costs and requires years of development and work with local government. It only requires a cleared landing area that is bigger than its football field size; no hangar or runway is required. Further reducing costs normally associated with air operations.[154]

The airship solution eliminates the reliance on standard infrastructure and opens more of the world for commercial development and lower-cost sustainment operations. Hybrid Enterprises outlines the advantages as follows:

> …more than two-thirds of the world's land area and more than half the world's population have no direct access to paved roads. As you move further away from infrastructure, cost, time, and the safety of transport becomes more of a challenge. Hybrid airships enable affordable and safe delivery of heavy cargo and personnel virtually anywhere.[155]

This option would be ideal for the RCAF to invest in for remote operations in the Arctic and specifically CFS Alert. Airships will thus "reduce the cost and environmental impact of remote op-

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[153] "Hybrid Airship," Hybrid Enterprises/Lockheed Martin, last modified 27 November, accessed 28 February, 2016, http://hybridhe.com/news-current/lockheed-martin-hybrid-airship-certification-plan-commercial-transport-approved-faa/

[154] "Can 'Superblimp' Unlock Hidden Riches of Africa?" CNN, last modified 24 February, accessed 28 February, 2016, http://www.cnn.com/2016/02/24/africa/superblimp-africa/index.html

[155] "Lockheed Martin Launches Worldwide Hybrid Airship Sales with Hybrid Enterprises," Hybrid Enterprises/Lockheed Martin, last modified 16 June, accessed 28 February, 2016, http://hybridhe.com/news-current/lockheed-martin-hybrid-airship-certification-plan-commercial-transport-approved-faa/

erations, making it possible to reach locations previously thought inaccessible."[156] The aircraft's air cushioned landing system allows for landing on virtually any surface, opening up the possibility of operations virtually anywhere; and expanding the possibly of sovereignty missions across areas of the Arctic previously thought inaccessible. Fully 80 percent of its lift is derived from buoyancy while the remaining 20 percent comes for standard aerodynamic from its tri-lobe, envelope design, or direct lift like current transport aircraft and helicopters, due to its helium filled cells. This would negate some of the fuel requirements for strategic airlift and range limitations of RCAF rotary-winged aircraft. Unlike current RCAF air mobility aircraft, the airship can carry 47,000 lbs of payload and up to 19 passengers. It can travel up to 1400 NM at 60 knot cruise speed, and has a 10'x10'x 60' cargo bay, with a crew of only two.[157]

Airships could also be operated virtually non-stop for CFS Alert sustainment flights, dramatically reducing the reliance on weekly sustainment flights from the CC-130J and CC-177. This would have a spill-over effect of further reduction to reliance on Operation BOXTOP for supplies. With a 23 Ton capability the airship could also virtually eliminate the need to ship cargo via barge from the Port of Montreal to Thule. While the planned airships cannot carry as much as either the CC-130J or CC-177, it can operate virtually non-stop and requires a fraction of the fuel that either current strategic airlift aircraft does. [158]

There are, however, a few drawbacks to the airship option. Because these aircraft are lightweight and there would have to be considerations for weather, especially winds, given its slow relative airspeed. Another disadvantage would be the requirement to refuel en route. With a

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[156] Ibid.
[157] Hybrid Enterprises, *Hybrid Airship*, http://hybridhe.com/news/lockheed-martin-launches-worldwide-hybrid-airship-sales-hybrid-enterprises/
[158] Royal Canadian Air Force, *Royal Canadian Air Force Aircraft*, http://www.rcaf-arc.forces.gc.ca/en/aircraft.page. By comparison the RCAF CC-177 has a maximum payload of 170,000 lbs and 181,054 lbs max useable fuel and the CC-130J payload of 48,000 lbs.

1400 NM range, an airship would likely need to stop in an Arctic community like Iqaluit to ensure, just like current RCAF aircraft, it had enough fuel to reach its destination and to make alternate plans should weather or some emergency force it to divert, even though it can set down virtually anywhere. The distance from 8 Wing Trenton to CFS Alert is approximately 2200 NM.[159]

Due to its slow speeds, it seems less likely that an airship would be used as an effective and fast means to transport passengers. That would mean a flight time of at least 36 hours based on varying meteorological conditions not interfering with its speed, and does not take into account the need to stop for fuel and likely some sort of crew rest.[160]

Another point to consider is the manning of such an aircraft. Personnel requirements would require consideration for manning of a Squadron, maintenance, and extensive time for operations due to speed/distance. Perhaps this would be a situation where the RCAF could employ contracted or leased aircraft, but maintained and owned by the company.[161] Calling to mind the contracted airlift option outlined above, perhaps a situation where a company is hired to handle virtually all aspects would be most appropriate, thus relying on the corporation to pilot, maintain, etc. the airships. In this case the aircraft could simply come under the Operational Command (OPCOM) of Commander 1 Canadian Air Division (1 CAD) for Commander CJOC like all

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[159] Hybrid Enterprises, *Hybrid Airship*. http://hybridhe.com/news/lockheed-martin-launches-worldwide-hybrid-airship-sales-hybrid-enterprises/The fuel capacity of the Lockheed Martin/Hybrid Enterprises airship is specified at 10,000 lbs. Along with its 47,000 lbs stated payload; it is significant cost savings over current RCAF airlift above. Although the range and speed of the CC-177 does not compare to the airship, the cost effectiveness highlights its potential.

[160] Ibid., Royal Canadian Air Force, *Flight Operations Manual- Effective 0001Z 21 Mar 2016 to 0000Z 21 June 2016*, 176. Calculations are based upon given speeds (60 knot cruise), stated ranges (1400 NM) and distance to Alert from Trenton (2200 NM) as well as 1 CAD crew duty day.

[161] "Snowbird Aircraft Replacement Project (SARP)," National Defence and the Canadian Armed Forces, accessed 5 May, 2016, http://www.forces.gc.ca/en/business-defence-acquisition-guide-2015/aerospace-systems-347.page

RCAF aircraft do currently.[162] This would enable tasking for global operations like any Strategic airlift.

However, these airships would be a force multiplier in any number of CAF operations. Already mentioned were sovereignty missions in areas previously impossible to reach by current air assets. However, it must be considered that airships could be used for Search and Rescue Missions across isolated areas of the country, as well as global air mobility sustainment operations. These could be huge force multipliers for comparatively low cost as they are "expected to run in the tens of millions of dollars,"[163] though currently no actual costs have been released.[164] By comparison, the purchase of the fifth RCAF CC-177 was estimated to cost $415 million which included spare parts and maintenance, or between $170-218 million for the airframe.[165]

Loss of training opportunities for air and ground crews should be considered in a number of these recommendations; essentially any that result in a reduction of Operation BOXTOP. Anecdotally, aircrews believe that a reduction in BOXTOP would mean loss of training opportunities for themselves and ground crew in what is, in their perspective, a relatively straightforward operation. However, Colonel Colin Keiver, the 8 Wing Commander does not believe that there is a great deal gained in the form of training during BOXTOP. He feels that the environment is one of the harshest that his squadrons fly in, and if anything but simple. He says that "the folks we

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[162] Royal Canadian Air Force, *1 Canadian Air Division*, http://www.rcaf-arc.forces.gc.ca/en/1-cdn-air-div/index.page Royal Canadian Air Force, *Royal Canadian Air Force Aircraft*, http://www.rcaf-arc.forces.gc.ca/en/aircraft.page This would be a situation similar to that found in the NATO Flying Training in Canada program aircraft at both 15 Wing Moose Jaw and 4 Wing Cold Lake which are leased and piloted by the RCAF, but maintained and provided by the contractor.

[163] CNN, *Can 'Superblimp' Unlock Hidden Riches of Africa?*, http://www.cnn.com/2016/02/24/africa/superblimp-africa/index.html

[164] "Hybrid Enterprises Receives First Customer's Letter of Intent to Purchase Lockheed Martin Airships," last modified 30 Marc, accessed 19 April, 2016, http://www.lockheedmartin.com/us/news/press-releases/2016/march/hybrid-enterprises-receives-first-customers-letter-of-intent-to-purchase-lockheed-martin-airships.html . Straightline Aviation signed a letter of intent to purchase 12 airships for almost $480 million, to include maintenance and spare parts.

[165] David Pugliese, "New RCAF Globemaster Lands in Canada," *Ottawa Citizen*, sec. Defence Watch, 31 March, 2015, http://ottawacitizen.com/news/national/defence-watch/new-rcaf-globemaster-lands-in-canada

send to BOXTOP need to be qualified to a high level in order to make it work which means it is much more of an operation than it is an FG [training] event."[166] Colonel Keiver believes that the experience garnered from operations sustaining the Station is not something that would suffer should BOXTOP be reduced or eliminated as the air mobility crews are "extremely busy conducting operations around the world and they would get that experience elsewhere."[167] Arctic training would still be attained given the number and variety of exercises each year, thus would not suffer either. Therefore and cost savings garnered from commercial airlift or the potential use of vehicles like the airships would have little overall effect on the force generation of RCAF crews and thus on their experience levels.

Energy Saving Measures

Energy consumption at CFS Alert is another avenue that should be examined during an RCAF comprehensive review on cost-saving measures. Due to the fact that JP-8[168] (designated DF-8 once it is offloaded into the DF-8 fuel farm) is used to both heat the closed-loop 50/50 water and glycol heating system (a heat recovery system) as well as run the generators for power[169], it is useful to examine both heating and power generation as sources of potential cost savings.

Defence Research and Development Canada commenced an energy study in 2011 to address such savings. It included multiple extended site visits, the installation of electrical submeters to monitor electrical loads in order to "provide insight into how the electricity is distributed to or used by the various buildings."[170] Detailed models were then developed for both electrical

[166] Colonel C. Keiver, RE: CFC DRP Assistance, 3 May, 2016.
[167] Ibid. The RCAF has embraced advanced simulation as another method to reduce the required YFR for training, and while the program is truly in its infancy in the RCAF, Canadian Forces Air Warfare Centre is confident that there will be little loss of experience with the switch to simulation due to their high fidelity.
[168] Gisele Amow, *Energy Audit Report of CFS Alert* (Ottawa: Natural Resources Canada/Defence Research and Development Canada, [2012]), 12.
[169] Ibid.,137.
[170] Ibid., iii.

usage and thus fuel consumption, providing a much needed baseline of empirical data which was used for all further testing.

The revelations from the extensive study were hardly surprising. "The two site visits," the study noted, "reveal that all buildings continue to suffer from high levels of infiltration (which result in high heating loads), inefficient light fixtures are still widely used with very limited instances of lighting controls present."[171] Additionally, the heating systems are not optimized and there are a number of issues of the use of incorrect equipment sizes with respect to pumps and heat exchangers. These findings led to a series of recommendations for each building which included both short (A through F) and long term (G and H) measures:

A) Repairing and sealing holes in the building envelope
B) Adding or replacing weather-stripping garage doors and man doors
C) Replacing incandescent light fixtures with compact fluorescent fixtures
D) Controlling light fixtures with occupancy sensors
E) Incorporating a boiler control strategy to prevent overheating
F) Replacing the secondary heat recovery loop pump motors with correctly sized units
G) Upgrading building envelopes to increase thermal resistance and lower air leakage
H) Replacing high bay light fixtures with induction lights offering lower power consumption, longer service life and improved control[172]

The final report also included a detailed Statement of Work which recommended 98 separate improvements to the Station.[173] The cost would have been approximately $640,000 to implement, however the fuel savings would be approximately 700,000 litres of DF-8 per year and saved an estimated $2,750,000 per Table 2 below, but does not consider cost savings in terms of YFR. The long term measures take into account the implementation of short term measures.

[171] Ibid., iv.
[172] Ibid., iv.
[173] Amow, *Alert Energy Measures Statement of Work*, iv-v.

Table 3.1 – Anticipated Annual Electricity and Fuel Savings Implementing Proposed Short Term and Long Term Efficiency Measures

Efficiency Measure	Electrical Savings	Heating Fuel Savings	Cost Savings
Short Term	**650,000 kWh**	**93,000 L**	**$540,000**
Long Term Building Envelope Upgrade	**1,000,000 kWh**	**274,000 L**	**$1,100,000**
Long Term High Bay Light Fixture Upgrade	**1,150,000 kWh**	**76,000 L**	**$770,000**
All Measures	**1,500,000 kWh**	**257,000 L**	**$1,330,000**

Sources: Amow, *Energy Audit Report of CFS Alert*, v.

Based on 2013 consumption, implementation of these recommendations would decrease the Alert requirements from 2,234,270 litres per year to 1,534,270 litres per year for heating and power generation, and would be annualized savings. This translates into the elimination of seven CC-177 BOXTOP flights, and 18.9 flying hours. Conversely this would translate to fourteen CC-177 sustainment flights under the current procedures or 250 CC-130 sustainment flights under the current plan. Savings would be best realized during Operation BOXTOP as it would eliminate the need for even more flights due to the proximity of Thule and Alert.[174]

The payback period should also be considered when energy savings measures such as these are considered. Payback is the total time it would take for the costs savings to be realized

[174] Calculations conducted based upon numbers previously outlined in the chapter. CC-177 fuel offload on SF, 50k L, on BOXTOP 100k L. CC-130 SF offload 2.8K L. CC-177 hours for each BOXTOP sortie is 2.7.

based on cost of implementation compared to cost of fuel saved. Again, YFR is not factored into these calculations. In this case the short term measures cost $77,500 and will realize payback in two months. High Bay Light Fixtures would cost $204,000 and take four months for payback. The Building Envelope would cost the most at $7,065,000 with a payback in 6.5 years. The total cost of all energy saving measures would be $7,382,500 and would take 5.5 years.[175] Further cost breakdowns are available in the Statement of Work which outlined each line item based on costs estimates at that time.

Inventory Control

Inventory control at CFS Alert should also be examined. Over the years inventory has accumulated on Station and there is no single point of control. Ray Hogan, the Nasittuq Site Manager (CFS Alert civilian contractors), said the following about poor inventory control at the Station: "the comments made about Alert mismanagement of material are not a true statement. There isn't any management of CE/Trades material; there is limited vehicle maintenance management of material."[176] This situation has resulted in an accumulation of excessive stock on site, consisting of everything from wood, vehicle parts, plumbing, electrical, and construction supplies and tons of wire spools left over from 1960s. Much of the materiel on stock has been lost over the decades due to sheer volume, necessitating annual purchases for items that may in fact already exist on Station.[177]

Based on discussions with both military and Nasittuq personnel, it can reasonably be expected to take up to three dedicated people a year to find, catalogue, and implement an effective

[175] Ibid., 5. Calculations taken directly from Table 3.
[176] Ray Hogan, "Supply Notes for Visit may 2016" (Speaking notes, CFS Alert, 2016b). It takes Station staff approximately two months to open and unload the average of 335 pallets received in the fall BOXTOP. They complete the effort in time for the next cycle to begin and rarely have the time required to do anything other than verifying that the correct supplies arrived.
[177] Ibid.

inventory control system, which should then be managed on an ongoing basis in order to provide the greatest benefit.[178] Additionally, as Hogan notes further, due to a lack of inventory control, "we have to go looking and that takes time. To pay a tradesperson to hunt down parts for regular maintenance is not very cost effective. In emergencies, it is could be disastrous."[179] This inventory control could also see a benefit through the removal of excess or useless items left over from decades of projects. There currently exists an estimated $1,000,000 worth of copper wire left over on Station that could be sent for recycling.[180]

Food Logistics

Better control of food purchased for Alert is another part of overall cost reductions. Enhanced purchasing and contracting practices are needed to ensure fresh food is delivered with appropriate expiry dates. A good example of this is with dairy products. During the fall of 2014, the Station was wasting an average $1500/month on expired foods of various types, and with a change in dairy contractor, that number increased dramatically. Upon investigation it was determined that the increase was due to the new contractors' practice of buying discounted dairy closer to its expiry date to reduce their costs. This resulted in greater costs for the RCAF as the product would arrive in Alert already expired or close to its expiry date, necessitating the discarding of the food due to safe food handling practices. The RCAF thus often had to expend twice as much due to expired products. After Wing Foods interceded on behalf of the Station, the underlying issue was discovered and a new contractor was sought. The result has been less spoilage (December 2014 food spoilage was only $279.01) and more cargo space available since the Station does not have to duplicate purchases.[181]

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[178] Ray Hogan, RE: JCSP Research Paper Help- 13:45, 19 April, 2016.
[179] Hogan, *Supply Notes for Visit may 2016*
[180] Hogan, *RE: JCSP Research Paper Help- 13:45*
[181] CFS Alert Food Services Officer, Food Spoilage at CFS Alert, 2014.

Conclusion

Alternatives to operational methods for the cost reduction of Operation BOXTOP prove that they provide tangible financial cost savings if chosen for implementation. While the use of Canadian airfields as an alternative to Thule AB as a sustainment HUB do not prove to be economically feasible for the CAF, this may prove to be a suitable option in the future if a Whole of Government approach is taken so as to reduce the financial strain on the CAF. Commercial airlift is an option, but as the numbers pointed out, the option does little to decrease costs to BOXTOP and thus should only be considered in the event of maintenance or operational unavailability of air mobility assets. The energy saving measures recommended in the DRDC study prove to be very valuable, tangible cost saving initiatives that require little relatively little expenditure in the short term, but provide dramatic annualized cost savings in terms of fuel flown to the Station and thus the associated YFR as well. Finally, other inventory and logistics measures were examined and determined that while the cost savings were lower, they would contribute to long-term decreases in costs.

IMPACT OF PROPOSED CHANGES ON ARCTIC AND GLOBAL AIR MOBIITY OPERATIONS

Cost savings in the manner outlined in this paper can be realized on any RCAF operation, whether it be another location in the Arctic, or on global air mobility operations. Those savings are a matter of scale and their actualization requires forethought and planning, which the CAF does not always have. However, other Arctic operations certainly could benefit from these recommendations.

While potential changes to the Government of Canada's policy on the Arctic may arise from the 2015 federal elections, there can be no doubt as to the former Conservative governments' unequivocal stance on the Arctic. Since the mid-2000's Canada has re-focussed on the Arctic, and this became especially apparent Prime Minister Harper's 2005 campaign platform which saw the Arctic as a top political priority. The campaigning Harper repeatedly re-iterated a commitment to strengthening Arctic sovereignty and security. This Arctic focus can best be seen in the Canada First Defence Strategy (CFDS) which lists six core missions for the CAF within Canada, North America, and internationally. The first of which is to "conduct daily domestic and continental operations, including in the Arctic and through NORAD."[182] This remains clear direction to the CAF on the importance the Arctic plays in government policy. CFDS implies new and emerging capabilities for the Arctic, one of the results of which can be seen in the Arctic Offshore Patrol Ship, and elucidates that Canada faces new and emerging security challenges.[183] Additionally, CFDS states that:

> ...the paradigm that has emerged since the end of the Cold War and recognizes that in hindsight, the peace dividend was short lived. Canada did

[182] Department of National Defence, *Canada First Defence Strategy*, 3.
[183] Ibid., 6.

> not immediately understand the evolving security environment and as a result did not fully appreciate the implications of Arctic sovereignty.[184]

CFDS goes on to state that "the Canadian Forces must have the capacity to exercise control over and defend Canada's sovereignty in the Arctic."[185] These are clear statement that have often been lacking from government direction to the CAF. It implies that SIGINT as a means of conducting daily operations in the forwarding of the arctic sovereignty role that Alert carries out as well as their national security function are required. This also implies that the N-Series of Arctic exercises will remain, if not expand in scope and importance and thus the need for sustainment operations in isolated Arctic environments remains.

Can the steps outlined in the paper apply to other Arctic and global air mobility operations or are they only applicable to CFS Alert? The fact is that many of the recommendations throughout this paper are applicable to any Base, Wing, Station, or deployed operation; at least holistically. Infrastructure must be planned appropriately to take into consideration the environment and the costs associated with power generation. Whether power generation comes from JP-8 flown in by airlift for generators, or comes from the power grid, government facilities can benefit from the cost savings of proper insulation, lighting, and their planning and construction over the life of said building. That is a lesson learned from CFS Alert through its 65 years of operation, and one which is yet to be solved.

[184] Ziprick, *Leveraging Air Mobility to Support Canadian Arctic Sovereignty*, 23.
[185] Department of National Defence, *Canada First Defence Strategy*, 8.

CONCLUSIONS

In September 1958 the first Commanding Officer of CFS Alert, Lt E.H. Heavens, assumed command of the most northerly permanently-inhabited place on earth. Dramatic changes happened in the world and to the Station in the intervening decades between that cold September day and 30 July, 2014 when the author took command of the Station. However, those changes, while sweeping, did not change one important fact. CFS Alert is at the northern tip of the world and needs effective sustainment in order to carry out its SIGINT mission on behalf of the Government of Canada.

There are many challenges associated with operating in the High Arctic, and sustainment operations for CFS Alert are no different. A comprehensive plan for the future of Alert should be undertaken by all of the stakeholders in order to developed and implement a plan before too much money is required to be spent on failing infrastructure that is, in many cases, approaching 40 years old.

This paper has examined a number of operational and non-operational methods. Any number of these methods would realize cost savings, yet it is only through the implementation of most or all recommendations that the RCAF can see maximized cost savings for Operation BOXTOP which would mean the dramatic reduction in the length and requirement for BOXTOP, translating in to both fiscal and YFR savings.

While implementation of all cost savings measures would undoubtedly dramatically reduce the length and cost of Operation BOXTOP, these measures could be implemented in a phased approach. In the first phase, 8 Wing could appoint an Alert OPI at 2 Air Movements Squadron, and Wing Foods, in conjunction with the Alert Food Services Officer, could monitor existing changes to food procurement practises almost immediately. This would reap small divi-

dends, but the OPI at 2 Air Movements Squadron will lead to better management of cargo and an overall positive effect towards the reduction of Operation BOXTOP.

In the second phase, implementation of an additional day (and two fuel sorties on that day) for each CC-177 weekly SF will have an immediate and dramatic impact on the need for fuel delivery during BOXTOP; essentially eliminating the requirement for JP-8/DF-8 fuel delivery during BOXTOP. The implementation of this recommendation would see the reduction of fuel requirements to less than half of their current needs; reducing the delivery of fuel to the Station to 13 sustainment flights from what would now take 54 flights. It is also recommended that during the second phase, more of the DRDC energy projects are implemented, especially those that are low cost for high return. Most of the projects individually are less than $10,000[186] and can be added as funds become available or as groups of smaller projects; the majority of which can be completed by CAF/Nasittuq staff already on Station. While implementation may take time, the long-term benefit of reducing fuel consumption by approximately 257,000 litres/year worth an estimated $1,330,000 is dramatic and would further reduce dependence on BOXTOP.

Finally, in the long-term, it is recommended that the Nasittuq contract be amended to allow for two-three individuals to be hired for inventory control. This would entail all the steps outlined in chapter 4, but would dramatically reduce waste for projects with costs passed on to the RCAF through the purchase of duplicate supplies, and the associated fuel required for transport. This would have an additional benefit of reducing waste currently sitting on Station as well as associated environmental concerns simply by taking advantage of empty aircraft heading south, and could be translated into some cost recovery by recycling all of the applicable material.

CFS Alert is a strategic asset for the Government of Canada. Due to its location in the High Arctic, it requires specialized sustainment operations to ensure that it operates as required.

[186] Amow, *Alert Energy Measures Statement of Work*

Operation BOXTOP has been the ongoing sustainment operation for the past 65 years. It has been the critical lifeline to supply the Station with its annual requirement of aviation and heating fuel, food, construction materials, and spare parts. Although it has effectively provided that critical re-supply, it has not done so in the most efficient manner. The costs associated with the Station sustainment can be reduced dramatically and the efficiencies outlined in the paper for both CFS Alert and Operation BOXTOP can realize dramatic cost savings and flying hour reductions for the RCAF.

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