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THE NEED TO INVEST IN CANADA'S SEARCH AND RESCUE SYSTEM WITH THE INTRODUCTION OF AIRBORNE SENSORS

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Through your courage and skill, you have saved countless lives[1]

- Jean Chrétien

Former Prime Minister Jean Chrétien may have meant the above quoted accolade when he said it during the fiftieth anniversary of the Canadian Forces' Search and Rescue services to Canadians, but the success of those military personnel, through "courage and skill", comes despite some neglect in investing in the modernization of Canada's primary Search and Rescue (SAR) services. As will be shown, there is yet a long way to go, through the proper introduction of airborne sensor technologies, in developing a modern SAR system through which further countless lives may be saved in the future.

As a frontier aviation nation, Canada has had a long and distinguished history in the development of flight.[2] In particular, this progress has helped enable the post-colonial expansion throughout the vast reaches of early Canada's empty geography, especially as a lifeline to the development and sustenance of northern communities. It has also led to Canada's extraordinary contributions to aviation efforts in both World Wars, both as a provider of skilled and courageous aircrews, and as a respected and essential flying training haven for our allies.[3] In addition, the inevitable need to provide assistance to those in distress in such a large country, either as a result of flying or maritime mishaps, has spawned an indispensable search and rescue system upon which Canadians have come to rely.

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[1] Department of National Defence, *Canadian Forces Search and Rescue: 50 Years of Service to Canadians* (Ottawa: Art Direction CFSU(O) Creative Services, 1997), 3.

[2] John Melady, *Pilots: Canadian Stories From the Cockpit* (Toronto: McClelland and Stewart Inc., 1989), 13, 19.

[3] Douglas L Bland, *Canada's National Defence: Volume 1 Defence Policy* (Kingston: Queen's University School of Policy Studies, 1997), 15.

The development of the search and rescue system in Canada grew in lockstep with both the demand of responding to distress cases in a still hazardous aviation environment, as well as the burgeoning needs of the fishing industries off both coasts. The mandate for SAR response within Canada eventually focused on response to all aviation distress cases, but limited itself to marine cases located in the oceans, and in the inland waterways of the Great Lakes and the St. Lawrence River.[4] The statutory limitations of the provision of SAR service to Canadians by the federal government notwithstanding, in fact public expectations far exceed such literal interpretations, and have continued to drive demand for response to boating incidents in particular, regardless of whether or not the location of such distress cases falls within federally mandated parameters.[5] Such demands on the SAR system, as well as other humanitarian type responses that do not qualify literally for assistance, have combined to produce the current *de facto* search and rescue system in Canada, one which Canadians take for granted will be there when required, and of which they are proud. Although the broader SAR system in Canada includes air, maritime and land resources from a number of agencies, the emphasis here will be restricted to the Canadian Forces' air component.

When search and rescue aircraft are sent initially to respond to cases of missing ships or aircraft, the chance of finding the search target will often depend on the reception of electronic distress signals or radio calls.[6] Failing any obvious means of locating the missing search target, the methodology of visual searching is then used. This means that observers onboard the aircraft will literally look out the windows, scanning with their

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[4] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical and Maritime Search and Rescue Manual (IAMSAR) Volume IV Canadian Supplement* (Ottawa: DND Canada, 2001), A1-1.

[5] *Ibid*, B7-5.

eyes in hopes of spotting the missing ship or aircraft of interest.[7] As can be imagined, such effort can demand a huge amount of time and money, and its risk is compounded by many factors such as difficult terrain, poor weather, and crew fatigue after prolonged search operations. This has proven to be a necessary but expensive means of locating lost ships and aircraft, and an entire visual search methodology has been developed to increase the probability of detecting search targets.[8] It is now also possible to complement such visual search efforts with remote imaging, but Canada has not yet made a serious effort to do so.

Technological advances in the use of remote sensing in recent years have prompted the introduction of a variety of sensor technologies in the military capability spectrum, throughout all combat related functions. Such systems as infrared (IR) and electro-optic (EO) imaging, and different types of radar applications, have matured to the point where their use is becoming prevalent in many mainstream military capabilities.[9] Sensor systems may be satellite or aircraft based, or increasingly can be found in the use of Uninhabited Air Vehicles (UAVs).[10]

Both the technical capabilities and cost factors resulting from the economies of scale of these maturing technologies have progressed to the point that they are available and affordable options for a wide range of military and commercial applications. In particular, there are advantages to the use of such sensor systems on airborne search and

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[6] *Ibid*, B2-2.
[7] *Ibid*, B4-21.
[8] *Ibid*, B4-18.
[9] Ronald G. Driggers, Paul Cox, and Timothy Edwards, *Introduction to Infrared and Electro-Optical Systems* (Norwood: Artech House, Inc., 1999), 334.
[10] James S. Corum, "Airpower and Peace Enforcement," *Airpower Journal* (Winter 1996): 18.

rescue aircraft, even over the benefits of more autonomously based systems such as satellites and UAVs.

For the purposes of this discussion, the definition of airborne sensors will be limited to such capabilities as infrared, electro-optic, and radar systems. Other types of systems which may be otherwise considered sensors, such as radios, Emergency Locator Transmission (ELT) homing equipment, and Night Vision Goggles (NVGs), will be referred to as their contributions relate to SAR, but they are already in mainstream use within the SAR system. The focus of upgrading current technological deficiencies will be on newer IR, EO and radar capabilities, whose imaging products can be integrated into on-board displays, retained for future use, and which are not currently resident in the Canadian Forces' primary SAR aircraft.

Even though search and rescue equipment projects do on occasion receive prioritized consideration within the Defence Department, in fact Canada has lagged behind considerably in updating the SAR system to benefit from such developments as sensor technologies. Despite the recent acquisition of a new SAR helicopter, the CH149 Cormorant, which as of 2004 is still being introduced into service, the CF has not kept pace technologically in the SAR system, in comparison to other defence efforts.[11] This is largely due to the budgeting realities of Canadian defence procurement, and the fact that Air Force SAR projects must compete directly within the Defence Department, against core combat capabilities, for funding. This placement of SAR as the poor cousin in DND as far as sensors are concerned, if uncorrected, will soon lead to the technological stagnation of a critical service to Canadians.

[11] David M. North, "Heritage Payoff," *Aviation Week and Space Technology*, January 26, 2004: 44.

Some efforts are being made to rectify this deficiency, but the restrictive funding climate in DND will need to be overcome, at least insofar as the SAR component within the capital program is concerned, in order to achieve a satisfactory investment level for the procurement of airborne imaging systems for search and rescue. To a limited extent, there is currently a trial project to enable testing of airborne sensors on-board the CC130 Hercules for SAR applications.[12] More ambitiously, the new Fixed-Wing SAR (FWSAR) project cites requirements for an integrated airborne sensor system in a new SAR aircraft, but its success will depend heavily on unprecedented funding support for such capabilities in the SAR system.[13]

In addition to the need to introduce a modern airborne sensor capability for search and rescue, there is an opportunity for the fleet of primary SAR aircraft to contribute more robustly to national security endeavors, if they were adequately equipped with such sensor capabilities. There is a serious projected deficiency in Canada's coastal surveillance capabilities, which are provided both by the Canadian Forces and the Department of Fisheries and Oceans (which includes the Canadian Coast Guard). The ability of the search and rescue fleet of aircraft in the Air Force, if adequately equipped, to contribute to such surveillance requirements within the new security environment, could be optimized ideally due to both the presence and SAR readiness posture of these aircraft and crews.

Therefore, to date, the aircraft used in providing primary search and rescue response, both to Canadians domestically and in our international commitments over the

[12] Department of National Defence, *Statement of Operational Requirement: Rapid Mount Airborne Sensor (RMAS) System* (Ottawa: DND Canada, 2000), 1.
[13] Department of National Defence, *Statement of Operational Requirement: Fixed-Wing Search and Rescue Project* (Ottawa: DND Canada, 2003), 10.

oceans, have not incorporated any substantial use of airborne sensor technologies, despite the availability and widespread use of such systems in other military applications. It is time to overcome the funding limitations for the primary SAR system resulting from competing military capital projects, and invest in airborne sensor technologies to improve the capability of the system to save lives, thus meeting Canadians' expectations. The advent of such systems is not only necessary for the continuing vitality of SAR service to Canadians, but such capability could also augment Canada's otherwise deficient coastal surveillance capabilities in an uncertain security environment.

In order to support this contention that airborne sensors are essential to the continued viability of the Canadian SAR system, an examination will be made of the background, history and development of search and rescue in Canada, including the assumption of responsibility for air response to SAR incidents by the Air Force. This will include DND's role in the provision of the federal search and rescue service, as well as discussion on the difficulties of overcoming funding pressures for search and rescue aircraft projects, due to the fact that the federal aviation component of the SAR system belongs to the Air Force, and hence its financial situation is inextricably embedded in the military budget process.

In addition, current methodologies for visual searching of distress victims will be studied, along with an analysis of current deficiencies with both search methodology and other aspects of the search and rescue system. Such deficiencies will be linked to the corrective benefits of augmenting the SAR system with the use of airborne sensors on primary search platforms. It will also be demonstrated that such modernization of the primary SAR system could constitute one component of a more optimized system of

Canada's coastal surveillance, thereby contributing to national security aims with a sensor-capable fleet of SAR aircraft that would already have the requisite readiness posture and surveillance capabilities.

BACKGROUND

In order to appreciate the Air Force's role in search and rescue, it is important to understand historically why the Air Force assumed such responsibility, and the extent to which the current Air Force is currently the sole provider of SAR to Canadians in certain capability areas. This will demonstrate the need to continue to modernize current SAR capabilities to ensure the success of future responses to SAR incidents.

On March 12, 1908, Casey Baldwin became Canada's first pilot, when he flew the *Red Wing* the distance of a football field at an altitude of about six feet.[14] This feat occurred in Hammondsport, New York, not in Canada, because Alexander Graham Bell and his Aerial Experiment Association had sought warmer weather there to conduct their flying experiments, rather than in Nova Scotia. Eventually they made history in Canada where, on February 23, 1909, John McCurdy became the first man to fly in Canada, in the *Silver Dart* at Baddeck, Nova Scotia.[15]

At Petawawa, Ontario, on August 2, 1909, Baldwin and McCurdy put on a flying demonstration for the military, hoping to convince them of its potential value. For, "until that time, the military had looked upon flying as little more than a passing fad."[16] After

[14] John Melady, *Pilots: Canadian Stories From the Cockpit…*, 15.
[15] *Ibid*, 17.
[16] *Ibid*, 18.

four successful flights, the fifth ended in a crash, convincing the military staff that the idea of the aircraft was a failure. "They agreed that it would have no military use."[17] How ironic then, that less than a century later, the Canadian Air Force in particular has the responsibility of responding to aeronautical and marine disasters with its own fleet of search and rescue aircraft.[18]

After World War II, the Royal Canadian Air Force (RCAF) was given the responsibility for Search and Rescue in Canada.[19] Cabinet authority for the RCAF aeronautical commitment was given in 1947, and in 1951 the Cabinet also gave the RCAF responsibility for maritime SAR coordination.[20] The Minister of National Defence was designated the Lead Minister for SAR in 1976.[21] Today, the responsibility for the provision of SAR service in Canada remains with the Canadian Forces, which has the responsibility for response of primary air assets to SAR incidents.[22]

The command and control structure for the SAR system is also embedded in DND, although the Canadian Coast Guard has the primary responsibility for the response of marine assets to SAR incidents.[23] The management of both Air Force and Coast Guard response is accomplished through the co-location of military and Coast Guard staff at the Joint Rescue Coordination Centres. However, despite these primary designations of SAR assets, in fact all federal government aircraft and vessels are also liable to be

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[17] *Ibid*, 18.

[18] Department of National Defence, B-GA-460-000/FP-000 *Search and Rescue Operational Doctrine* (Winnipeg: DND Canada, 1995), 2-4.

[19] Department of National Defence, *Challenge and Commitment: A Defence Policy for Canada* (Ottawa: Supply and Services Canada, 1987), 85.

[20] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical…,* A1-4.

[21] *Ibid*, A1-1.

[22] *Ibid*, A1-3.

[23] *Ibid*, A1-6.

tasked for response to SAR incidents if needed and when available. These are known as secondary SAR assets.[24]

The Canadian area of SAR responsibility is shown below. Its apex is at 90 degrees north latitude, the North Pole, and its eastern boundary extends to 30 degrees west longitude, midway across the Atlantic Ocean.[25] The total area of Canada's SAR responsibility covers over fifteen million square kilometers.[26] As it reflects internationally agreed upon boundaries for the provision of SAR services under the International Civil Aeronautics Organization (ICAO), as well as under International Maritime Organisation agreements for maritime SAR, it extends far beyond Canada's purely domestic interests in its territorial waters.[27] Such global division of SAR responsibilities among nations is the only way to ensure comprehensive coverage of the world's oceans for the management of rescue services. Of course, not all nations contribute equitable resources given the mandates they have accepted, but Canada in particular is serious in its assumption of search and rescue responsibilities.

The total Search and Rescue system in Canada is really comprised now of a variety of departments and agencies, but the air component of this system can be described broadly in three terms. First, there are primary SAR assets, which means roughly that each area of the country has one Air Force SAR helicopter, and one Air Force SAR fixed-wing aircraft, dedicated with aircrews on an immediate standby posture to respond to SAR distress cases. These primary Air Force SAR aircraft are the only aircraft in all of Canada that are immediately ready to respond, and have all-weather

[24] *Ibid*, A1-8.
[25] *Ibid*, Annex A2-3.
[26] Department of National Defence, *Challenge and Commitment…*, 85.
[27] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical…,* A1-1.

flying capability, and are also flown by crews that include Search and Rescue Technicians (SAR Techs) capable of providing rescue services. SAR Techs are able to parachute into a crash site, administer medical aid, and retrieve survivors via helicopter or any other available means. Examples of primary SAR assets are the CC115 Buffalo aircraft, the CC130 Hercules aircraft, the CH113 Labrador helicopter (being retired from service), and the CH149 Cormorant helicopter (being entered into service).[28] Even though it is new, the Cormorant helicopter does not have any useful sensor capabilities. Its search/weather radar is an older version, whose analog display characteristics were actually degraded when it was fitted to a digital display system. Hence, it is of very limited utility, and does not reflect available capabilities of current generation radar systems.

Secondly, all other Canadian Forces aircraft are considered secondary SAR assets, and can be tasked by the Joint Rescue Coordination Centres (JRCCs) if available.[29] Generally, these secondary assets do not carry SAR Techs, are not on any sort of response posture, and have very limited search capabilities, and no rescue capabilities. Exceptions may occur when these aircraft are put on an immediate response posture during periods when the primary SAR aircraft are unavailable, but generally secondary assets are only used when they happen to be the closest available resource.

Thirdly, other government departments, or other government-sanctioned resources may contribute to the air component of the SAR system, but this is in a very limited sense. The Canadian Coast Guard (CCG) does have helicopters, but they are for transport duties, are not on a SAR response posture, and do not have a rescue capability

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[28] *Ibid*, A2-21.
[29] *Ibid*, A5-1.

(at least not medically, although any helicopter may be used for retrieval of distress victims if weather and medical concerns are not factors). There is also a federal association known as the Civil Air Search and Rescue Association (CASARA), which is comprised of volunteer civilians who may maintain a SAR readiness posture in their geographical area, may be tasked by JRCC, and are reimbursed for training and operating expenses by the federal government. These assets are useful for initial response to ELT cases, and can be used to augment visual search operations by the Canadian Forces, but generally they are limited due to weather and manning restrictions, and cannot provide a rescue capability.[30]

Aside from these elements, which form the air component of the federal SAR system, there are other responsibilities in the federal SAR system. For the marine component, these are covered by Coast Guard and Navy vessels, as well as those of the merchant marine. It is important to note that there is a distinction between air and marine assets, such as aircraft and ships, that respond to distress cases, while the distress cases themselves are composed of air or marine incidents. That is, the intended response of the federal SAR system is to distress cases involving accidents with aircraft or ships. Other cases of distress, such as lost hunters or hikers, are missing persons cases whose jurisdiction belongs to the police. Nevertheless, it is common for the federal SAR system to respond to such cases if the situation warrants and resources are available. Although police forces may also have helicopters, which may be used in cases of missing persons, they do not generally contribute to the air component of the federal SAR system.

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[30] *Ibid*, B1-1.

The following table indicates the air assets used in the Canadian federal SAR system. Although all Canadian Forces aircraft may be considered secondary resources, only the ones most commonly used are depicted.

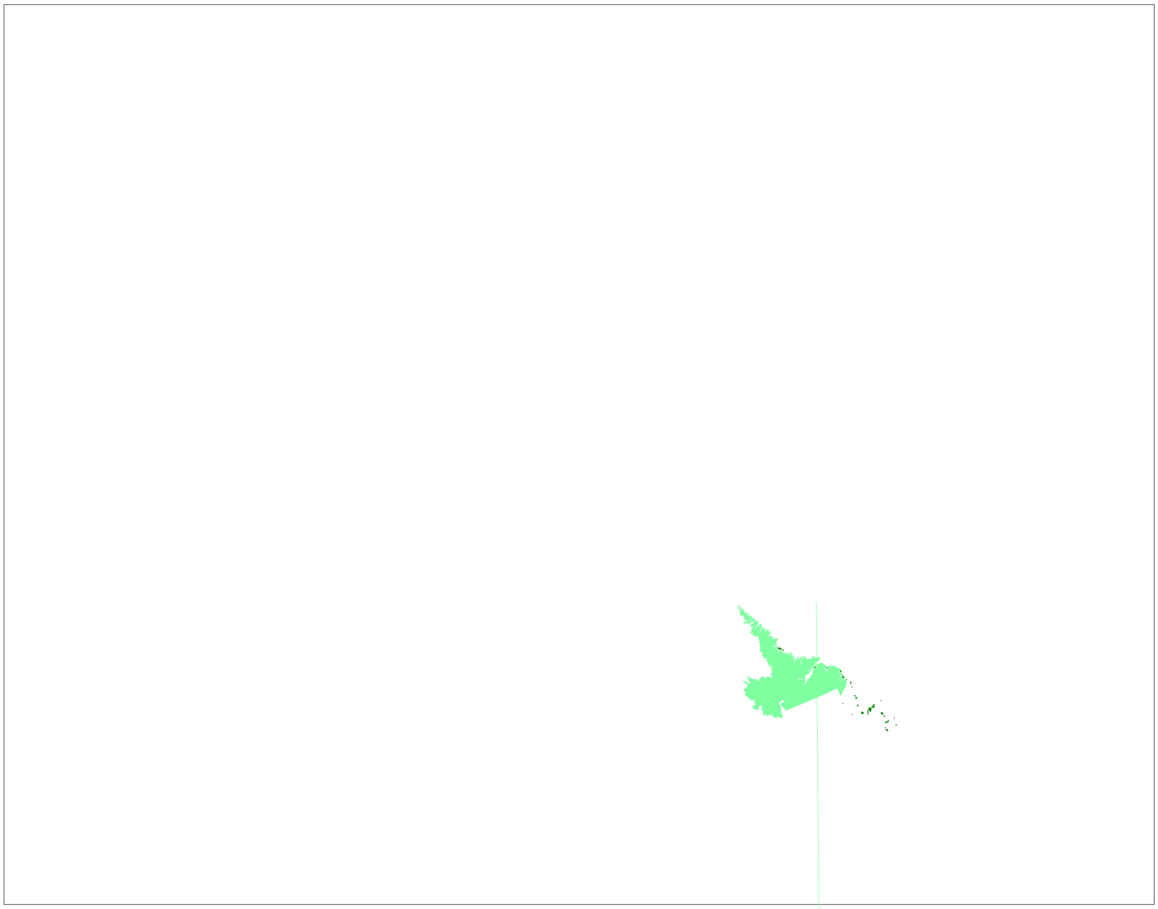
Federal SAR Assets – Air Component	
Primary – Canadian Forces (24 hour response)	**Location**
CC115 Buffalo – fixed wing	Comox, BC
CC130 Hercules – fixed wing	Winnipeg, MN Trenton, ON Greenwood, NS
CH149 Cormorant - helicopter	Comox, BC Greenwood, NS Gander, NL
CH113 Labrador - helicopter	Trenton, ON
Secondary – Canadian Forces (used when available)	
CP140 Aurora – fixed wing	Comox, BC Greenwood, NS
CH124 Sea King - helicopter	Victoria, BC Halifax, NS
CH146 Griffon - helicopter	Multiple locations
Other - Civil	
CASARA	Multiple locations

Table 1 – SAR Assets

The Canadian area of SAR responsibility is depicted in Figure 1. As can be seen on the map, this area goes well beyond the Economic Exclusion Zone, and is divided into three separate areas known as Search and Rescue Regions (SRRs).[31] The geographical difference in coverage results from the international agreements that different nations have committed to with respect to SAR responsibility, to ensure global coverage. Each

[31] *Ibid*, A2-18.

region has one Joint Rescue Coordination Centre (JRCC), to most effectively task the appropriate Air Force or Coast Guard primary SAR resources.[32]



Search and Rescue helicopters are routinely reported by the media as belonging to the Coast Guard. It is not a reflection on the Canadian Coast Guard that this lack of awareness undermines public support for defence spending in an area of actual Canadian spending priority. It is, however, a sad irony. Although it is impossible to accurately identify spending trends in SAR within the Canadian Forces, due to the intricate blending of SAR budgeting with other functional roles within the CF, it is possible that SAR funding as a federal priority would be treated much differently if it were not enmeshed in the military budget difficulties.

POLICY

Given that the funding of primary SAR air assets is a CF responsibility, it is worth examining the policy framework which determines the requirement for the SAR role, as it pertains to the CF. The Air Force's Mission Statement reads as follows: "The mission of Canada's Air Force is to generate and maintain combat-capable, multi-purpose air forces to meet Canada's defence objectives."[33] Whether or not this is intended to include search and rescue is unknown, but it is not explicitly stated here. However, the Air Force openly admits that, "In order to meet the challenges of the future, we cannot afford to maintain the status quo."[34]

The following chart shows the Spectrum of Conflict diagram, which conceptually places the eleven Defence Planning scenarios within certain expected ranges of

[33] Department of National Defence, *Vectors 2020: Toward Canada's Future Air Force* (Draft, Ottawa, 2003), 4.

[34] *Ibid*, 4.

intensity.[35] Although not doctrinal in itself, it frames illustrative planning scenarios, based on doctrinal tasks, to enable force planning analysis.[36] The scale ranges politically from peacetime to wartime conditions. Canadian Forces operations, as reflected in the planning scenarios, fall somewhere within either combat or non-combat designations, or both, as they happen to overlap in an area of uncertainty. Of the eleven Defence Planning scenarios, Search and Rescue in Canada is listed as number one, although not in priority, and falls within peacetime operations.

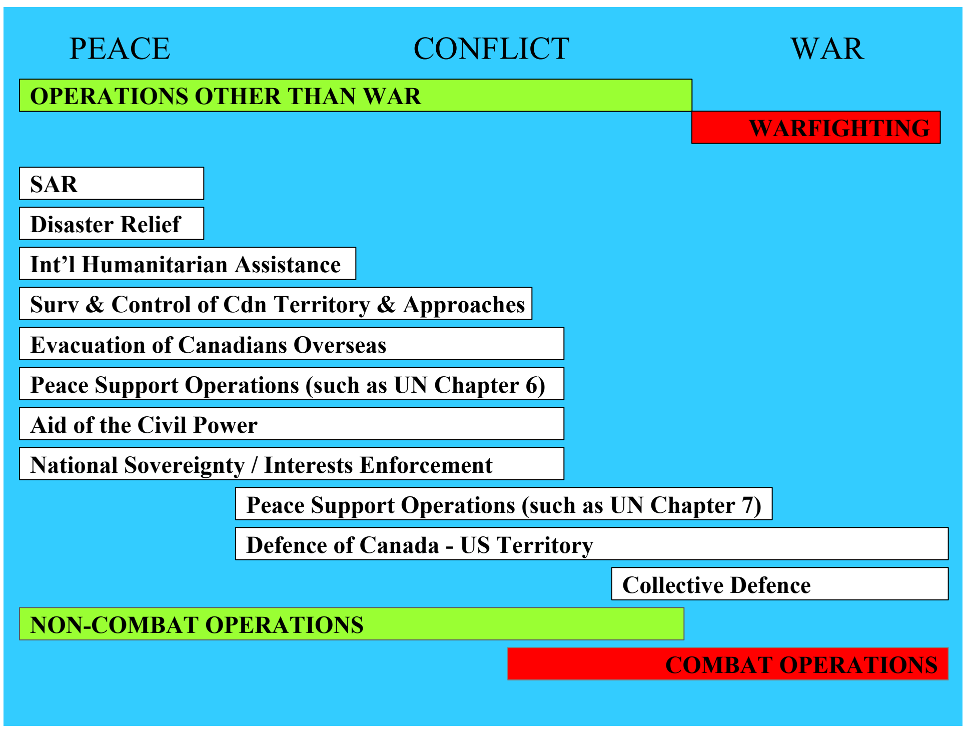


Figure 2 - The Spectrum of Conflict[37]

[35] Department of National Defence, B-GG-005-004/AF-000 *Canadian Forces Operations* (Ottawa: DND Canada, 2000), 1-4.

[36] Department of National Defence. *Concept Paper – Departmental Force Planning Scenarios (FPS)*; available from http://www.vcds.forces.gc.ca/dgsp/pubs/rep-pub/dda/scen_e.asp; Internet; accessed 1 May 2004.

[37] *Ibid.*

The inference, then, is that the search and rescue service provided by the Canadian Forces falls within the Non-Combat Operations portion of the Spectrum of Conflict. It is at the far left of the illustrated spectrum, under the Operations Other Than War (OOTW) category, and is also placed entirely in the safest range of conditions of peace. Note that Combat Search and Rescue (CSAR) is not specifically listed on this chart. It could of course be embedded within one of the other listed scenarios, but if it were, it would certainly appear somewhere in the range of Combat Operations. This clearly distinguishes that the federal SAR system in Canada, for which aeronautical response is the responsibility of the Air Force, is strictly a peacetime role.

From a historical perspective, Canada's doctrinal development of search and rescue seems to have wandered all over the map. In 1981, Canadian air doctrine stated that "SAR operations are conducted during peacetime and throughout the spectrum of conflict."[38] It also tellingly claimed that "It may be necessary to provide an air escort for some SAR missions, particularly those which involve penetration of enemy territory."[39]

When Canada's aerospace doctrine was updated in 1989, it once again elaborated on the need for a combat SAR capability: "When a requirement exists to conduct a SAR mission in an enemy controlled area, usually some form of protective fire must be coordinated to support the SAR operation."[40] Yet again in 1997, the newly updated air doctrine referred to CSAR operations, although with less emphasis: "It may even be necessary for SAR aircraft to escort certain combat missions."[41] Note that this is

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[38] Department of National Defence, B-GA-283-000/FP-000 *Conduct of Air Operations* (Ottawa: DND Canada, 1981), 8-41.

[39] *Ibid*, 8-42.

[40] Department of National Defence, B-GA-400-000/FP-000 *Basic Aerospace Doctrine* (Ottawa: DND Canada, 1989), 6-3-43.

[41] Department of National Defence, *Out of the Sun: Aerospace Doctrine for the Canadian Forces* (Winnipeg: Craig Kelman and Associates, Ltd., 1997), 110.

relatively recent history, yet there is no element at all of CSAR capability in the Canadian Forces, nor are there any efforts at training to such a standard. Combat SAR is a highly specialized capability that cannot be credibly created on an *ad hoc* basis.[42] In fact, it is reliant not only on specialized training, but also on dedicated aircraft such as the HH-60 helicopter and the HC-130 Hercules variant.[43]

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If the Canadian government feels the same way, it is not evident. It is presumably willing to rely on others' CSAR services to rescue our own Canadian Forces members at risk, because it makes no serious pretense of being doctrinally concerned with a combat SAR capability. It is perhaps not surprising then, that the current transformation initiative fails to address peacetime SAR at all.

In the 1987 White Paper on defence, the modernity of the Canadian Forces' role in search and rescue was expounded upon: "The Canadian Forces constantly improve their all-weather search and rescue capability."[48] Additionally, it refers to "…improving equipment and exploiting new technologies…" for the SAR system.[49] In 2004, however, there is no such laudable claim of technological improvements in the search and rescue system. In fact, while the Chief of the Defence Staff's (CDS) Annual Report for 2002-2003 is subtitled *A Time for Transformation*, it almost ignores the SAR capability altogether. To highlight the extent to which the search and rescue capability within the Air Force is ignored compared to core military capabilities, consider the following quote from the Defence Plan: "Canada's Air Forces consist of fighter aircraft, maritime helicopter and patrol aircraft, tactical helicopters and light transport aircraft, and training fleets."[50] There is not one mention of SAR resources anywhere in this statement, and the SAR helicopters in particular do not fall within any of the listed categories. It will not be surprising then, when the deficiency in sensor development in search and rescue is discussed later, that inadequate attention has been paid to technological improvements in this area.

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[48] Department of National Defence, *Challenge and Commitment…*, 85.
[49] *Ibid*, 85.
[50] Department of National Defence, *Defence Plan Online 03/04* (Ottawa: July 24, 2003), 80.

The choice to assign civilian SAR responsibilities to the CF is a discretionary one for the federal government, as the CF is not otherwise compelled to provide this service. It could well be assigned to some federally governed civil agency in any number of guises. In fact, there has been an over-riding pressure within DND during its budgetary cutback years to do exactly that with any non-core military capability resident within the CF. Such pressures have resulted in what is known as Alternative Service Delivery (ASD), where previous military services have been contracted out to civilian bidders.[51] Such outsourcing was directed in the 1994 Defence White Paper, in order to save money.[52] However, there are good reasons that DND has managed to retain primary SAR within the Air Force over the years, despite the prevalent view that non-core military capabilities must be shed from the CF in pursuit of saving money. An analysis of the SAR provision by the Air Force is relevant to the question regarding competition for funding within DND, and its effects on the federal SAR service.

The fact is, the delivery of primary SAR is generally a good news story for the Air Force, and for DND as a whole, although of course its *raison d'être* is to save lives, not leverage public relations. The question is, what is the advantage of having the public SAR service provided by the Air Force? Although search and rescue is taken very seriously within DND, it still has to compete with a myriad of under-funded and over-stretched capabilities within the department. There is no separation, or distinction, of funding sources within DND's allotted budget for the provision, or management, of SAR services. That said, SAR requirements do sometimes receive priority consideration in the

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[51] Director General Strategic Change website: available from http://www.vcds.forces.gc.ca/dgsc/pubs/how/ci/asd/goosebay_e.asp; Internet; accessed 23 April 2004.

[52] Department of National Defence, *1994 Defence White Paper* (Ottawa: Canada Communications Group, 1994), 42.

fight for capital funding. Whether this is from altruism due to the life-saving nature of search and rescue operations, or from political expediency in announcing "safe" projects for public consumption, is debatable.

There are two examples that highlight to some extent this willingness to prioritize SAR projects. First, there is the now infamous distinction between SAR and maritime helicopters that resulted from the Chretien government's cancellation in 1993 of the already approved order of fifty EH101 helicopters. Of the fifty that were ordered, fifteen were meant to replace the CH113 Labrador helicopters in search and rescue, and thirty-five were meant to replace the CH124 Sea King maritime helicopters. The government was compelled to resolve the SAR helicopter deficiency at almost any cost, even as it distastefully accepted a variant of the same aircraft it had just cancelled (the CH149 Cormorant), whereas the maritime helicopter fiasco lingers even into 2004, and undoubtedly beyond.[53]

Secondly, the Fixed-Wing SAR (FWSAR) project was announced as a government priority, shortly after the Future Strategic Airlift (FSA) project was cancelled. Although this appears to lend the SAR project some credence over other military priorities, in fact it remains to be seen if the airborne sensor capability requirements stated in the FWSAR project will survive the budget approval process.[54]

[53] Martin Shadwick, "The Chrétien Legacy," *Canadian Military Journal* (Winter 2003-2004): 68.

CURRENT SITUATION

Along with surveillance and control, SAR is one of the few Defence Tasks listed in the Defence Plan with a requirement for an immediate readiness posture.[55] Directing and controlling response to terrorist incidents also has the same priority.[56] This indicates the critical nature of all these tasks. In the case of SAR, the system that exists to administer this consists of a number of flying squadrons across Canada, as well as trained and dedicated SAR crews whose readiness levels are intended to provide twenty-four hours per day, seven days per week response. Unfortunately, the system is only manned to a minimal level of response. SAR crews are only ready for immediate take-off, required within thirty minutes of being tasked by the rescue centre, for a period of eight hours a day, five days a week.[57] The rest of the time, which comprises about 76 percent of the total time per week, typically at nights and on weekends, the crew is not in the hangar at the base ready to go, but rather at their individual homes with pagers. When tasked, they have two hours to be airborne for a SAR response.

This is an attempt to provide a 24-hour per day service on the cheap. It is a compromise between the government wishing to provide the emergency service, but not wanting to pay for it. This is because it allows a dedicated system with a smaller number of crews, due to the way crew day limitations are imposed. Once the crew is at work, they are consuming the time remaining in the allowable fifteen hours of crew day. However, in the two-hour response period, the crew's day does not start until the pager is

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[54] Department of National Defence, *Statement of Operational Requirement: Fixed-Wing Search and Rescue Project* (Ottawa: DND Canada, 2003), 80.

[55] Department of National Defence, *Defence Plan Online 03/04* (Ottawa: July 24, 2003), 7.

[56] *Ibid*, 10.

activated, so they can cover longer periods.[58] This allows less manning than a full time 30-minute response system would demand, but is less flexible and has no depth when intense periods of SAR activity consume available crew duty times.

Only the primary search and rescue aircraft are on 30-minute or two-hour response readiness postures. Other CF aircraft may also be tasked for SAR duties when available, as secondary SAR assets, but they do not generally have the detection and rescue capabilities of the primary SAR fleet.[59]

The visual search methodology itself uses “spotters”, or observers, who sit at aircraft windows and scan visually to find search targets, such as missing vessels or aircraft. Although binoculars are available to the spotters for inspecting targets, they are not used in the search scan, as the spotter must scan the eyes in a specific grid pattern to cover the search track as it moves underneath at more than one hundred nautical miles per hour. The binoculars' field of view is far too narrow to allow effective search scans while spotting along a search track. The search planning process is based on a body of operational research that has studied SAR cases, and attempts to optimize search tracks with the probability of being found. Unfortunately, it has a number of limitations. One such limitation is crew fatigue. SAR operations by necessity often disrupt normal sleep cycles, and fatigue is a serious factor in aviation generally. SAR spotters also become ineffective after about twenty minutes of visual searching, due to eye strain, so they must constantly rotate duties on long searches.

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[57] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical…,* A2-21.

[58] Department of National Defence, *1 Canadian Air Division (1 CAD) Orders: Volume 2 Flying Orders* (Winnipeg: November 30, 1999), F1/2.

[59] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical…*, A2-21.

Another limitation is the narrow search track to which visual search efforts are confined. Because of the strain involved, and the methodical sweep of the eyes in specific patterns to cover the ground most effectively, visual spotters only scan about one-half or one mile from the aircraft centerline. Also, aircraft search speeds are intentionally slow, about 100-140 knots typically, to allow the spotters good visual effectiveness. Otherwise, at low altitudes, which are necessary for visual target resolution, everything becomes a blur, negating the effort. This means that the combination of slow speed and tight tracks requires very lengthy search operations to cover any significant amount of ground. In addition, despite the efforts of operational researchers, some lost aircraft do not actually crash within the expected mathematical area of probability, so survivors in those cases have almost no chance of being detected in a visual search.

This of course would not apply to a search target with a functioning ELT, as there generally would not be a need to search visually for it. Those targets are usually found quickly. There is a parallel case, however, in how the ability to cue in to potential targets of interest can reduce search efforts. In the case of an ELT, the signal cues the visual search to a very confined location. Similarly, airborne sensors that can detect targets at much longer ranges than the track scan width of a visual search may provide similarly beneficial cueing. This would allow potential targets identified at long range by IR, EO or radar systems, for example, to be investigated visually immediately on arrival at the scene. By contrast, the visual track search methodology does not allow visual scans beyond a very confined track width. This is intentional, due to the demands of visual scanning and the related probabilities of detection, but it precludes any likelihood of visually cueing long-range targets, which is also compounded by the limits of human vision. Visual searching, on its own, is strictly a dissection of geographical plots along a search track or area, with no cueing prioritization available.

On occasion, a search and rescue aircraft itself is lost in an accident, due to the inherent risks of the SAR role. This has happened in the CF's history in recent decades to the CC130 Hercules, CC138 Twin Otter, and CH113 Labrador. In 1980, a SAR CC130 Hercules stalled and crashed in clear weather during a low altitude, low speed turn in a search operation.[60] These risks associated with flying at low altitudes close to the stall speed, where recovery from mistakes is impossible, are directly attributable to visual search procedures. Such risks are magnified immensely when flying in bad weather.

The environment in which search and rescue aircraft are compelled to fly during the course of their job is frequently dangerous and unforgiving. This is partly because of the unpredictable nature of weather, which can change drastically from one moment to the next when least expected.[61] SAR is also most often needed in bad weather because it is a frequent cause of distress incidents in the first place. Such frustration with the weather was experienced by the SAR crews who responded to the CC130 Hercules crash near Alert in 1991. Although the accident happened in clear weather, in the matter of hours it took SAR crews to arrive from the south, an arctic storm had developed, partially obscuring visibility in all directions, and delaying any rescue attempts by the SAR

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[60] Robert Mason Lee, *Death and Deliverance: The Haunting True Story of the Hercules Crash at the North Pole* (Toronto: MacFarlane Walter and Ross, 1992), 47.

[61] Department of National Defence, *Air Command Weather Manual, CFACM 2-700* (Winnipeg: DND Canada, 1984), 16-4.

aircraft.[62] Although some lives were ultimately saved in the attempt, some were also lost, due to the failure to effect a timely rescue.

In the west, the Canadian Rockies are another source of dangerous flying conditions due to severe and rapidly changing weather. High altitude winds flowing across the mountaintops create strong, invisible vortices that can literally flip airplanes around in circles.[63] In addition to the more obvious sources of adverse aviation weather risks, fog and low-lying cloud also contribute to a large share of aviation distress cases.[64] Each of these circumstances demand at times the most professional of capabilities and dedication from SAR crews, and it is no coincidence that these are often exactly the kinds of weather conditions that have been the cause of someone else's distress. Therefore, it is common that SAR flying operations are conducted in the worst of weather conditions, when someone is reported missing. The advent of effective weather-mitigating sensors would improve both the likelihood of saving lives and the risk factors for SAR crews themselves.

DEFICIENCIES

The impotence of the SAR system in the face of intractable weather conditions is the most paralyzing deficiency currently faced. The risks of conducting SAR operations in poor weather have been discussed, but weather also obstructs chances of detecting search targets. Low-level visual SAR operations are not possible in bad weather, and the

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[62] Robert Mason Lee, *Death and Deliverance…*, 105.

[63] Environment Canada, Atmospheric Environment Service, *AWARE: Aviation Weather All Ready for Emergency* (Ottawa: DND Canada, 1990), 163.

inability to penetrate visually to the ground in obscuring phenomena such as snow, sleet and rain often delays the critical timely identification of survivors.

The demands imposed on the SAR system in searching for lost targets could be better mitigated with more robust Emergency Locator Transmitter (ELT) standards. Although all registered aircraft are required to carry ELTs, they are not all sufficiently crashworthy to be of use. Government set standards of ELT performance are relatively low, so as not to impose undue costs on aircraft owners. However, studies of ELTs in the United States have shown that they o5018lhe 5 7001out 25 % of the time.[65] This compels visual search efforts in a large number of distress cases. Even when ELTs lhe 5 70 correctly, however, some means of dete 5 700t the site is still necessary, especially in heavi018lorested or difficult terrain, or partially obscured weather.

Visual search effe 5veness has been studied within DND, but op 5 7s to op 5mize0 visual search are limited.[66] The biggest impediment is due to weather, which can obscure0 visibility during the day or night. Spotters on search aircraft do use Night Vis5 70 Goggles (NVGs), but they are also subje to obscuring weather, are fatiguing due to eye strain and helmet weight, and have very narrow fields of view, reducing scan effe 5veness.

One constant difficulty in searching from fixed-wing aircraft is the inability to fixate on a target once sighted. The aircraft speed allows only a fleeting glimpse of potential targets, and in the 5me i takes to turn around the arget can be easily lost. The

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[64] John Melady, *Search and Rescue: When Disaster Strikes* (Markham: Scholastic Canada Ltd., 1999), 90.

[65] Tom I. Lukowski, and Francois J. Charbonneau, "Synthetic Aperture Radar and Search and Rescue…, 770.

[66] Defence Research and Development Canada, *Visual Search Capability in Search and Rescue(SAR)* (Toronto: May 15, 1974), Abstract.

lack of a recorded image in visual searching aggravates the attempt and necessity to re-acquire the target. Digital cameras are carried on SAR platforms, but they are only useful for recording known events. They are not useful for recording fleeting glimpses of targets while searching, and, unlike integral sensor systems, they cannot cue the pilot flying the aircraft back to the point of origin in order to re-acquire the target. Also, the probability of detection when searching visually is fairly low, unless under ideal lighting, terrain and contrast conditions.[67]

It is important to note that in certain cases, survivors may be extremely difficult to detect visually. Persons floating in water, especially in heavy seas, are almost impossible to see, and are easily lost from view while maneuvering fixed-wing aircraft at low altitude during rescue operations. Even on land, in undulating terrain the effect can be similar, especially in cases where there is virtually nothing left to see of the aircraft that crashed, although survivors may be present.

There was at least one incident where lives lost during a rescue operation were blamed publicly on inadequate airborne sensors on the CH124 Sea King.[68] In that case, in the middle of the Atlantic Ocean, four CH124 Sea King helicopters from a Canadian naval battle group attempted to rescue the survivors of a sinking Greek cargo ship.[69] The incident occurred on March 23, 2000, and ultimately thirteen of the ship's crew were saved, six bodies were found, and twelve more crew were declared lost at sea. The media report was based on a Defence Department internal report that stated: "Survivors were momentarily sighted and then lost at ranges of less than 40 yards because crews couldn't

[67] Department of National Defence, B-GA-209-001/FP001 *International Aeronautical…*, B4-20.
[68] CBC Newsworld. "Sea Kings Have No Effective Night Imaging System." Newsworld broadcast, 18 March, 2003.
[69] *Ibid.*

properly spot them in the dark."[70] The DND report, an apparently leaked Statement of Capability Deficiency, also concluded: "An inability to see in the dark was a contributing factor in the drowning of the remaining survivors."[71] The media report also laid blame on former Prime Minister Jean Chrétien for canceling the Sea King replacement in 1993: "I'll take my pen and I will write zero helicopter. Chrétien. That will be it."[72] The inference of course being that the new replacement helicopter would have had a modernized sensor capability to prevent such disasters. As was indicated earlier, however, the new SAR helicopter that resulted from the same cancelled project, the CH149 Cormorant, still was not procured with any airborne sensor capability.

The striking point about this incident is the blame assigned to the Air Force for failing to provide sufficient airborne sensor technology for SAR operations, in an aircraft that is not a primary SAR resource, was not in the Canadian area of SAR responsibility, and was not rescuing Canadians at the time. Clearly due diligence alone would dictate the need to upgrade primary CF SAR assets with appropriate sensors, in order to satisfy public expectations of the SAR system. It is not sufficient to argue that the Air Force is providing best effort for SAR. Whether or not it is provided by the CF, and whether or not it is also used as a military capability, the public expects and demands a modern, capable SAR fleet. Such expectations do not bode well for future failures of a similar nature in the primary SAR aircraft.

Examples of strained funding impacts on the SAR system include of course the cancellation and resurrection of the SAR helicopter project, but there are a number of less visible problems. They range from the simple acquisition of basic SAR equipment for

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[70] *Ibid.*
[71] *Ibid.*

Search and Rescue Technicians (SAR Techs) to use in the course of their duties, to antiquated computer systems in the SAR satellite alerting system, and to the very way the SAR system is manned.

SAR Techs have probably the widest range of qualifications of anyone in the Canadian Forces, with perhaps the exception of special forces personnel. SAR Tech's duties are extremely hazardous, and include parachuting into any unfamiliar terrain at any hour of the day or night, even into the middle of the ocean if necessary. As well, they are medically qualified as paramedics, and are trained in diving and mountain climbing, all in the name of preserving life of those in distress, for whom the SAR system functions. Yet, the CF is constantly fighting to approve funding for basic equipment upgrades to allow SAR Techs to perform their jobs.[73]

All this reveals an untenable pressure within DND to maintain and modernize its force structures, but without the financial resources to do it. This may explain why a non-core capability like SAR is over-looked. Returning once again to the CDS's Annual Report, an examination of the section on modernization is revealing in its treatment of search and rescue. While it discusses an extensive list of transformation initiatives for the CF, its only reference to search and rescue regards "…the on-going delivery of a fleet of 15 CH149 Cormorant search and rescue helicopters…"[74] At the same time, it emphasizes a number of improvements in C4ISR, including the surveillance monitoring capabilities of the CP140 Aurora (a maritime patrol aircraft routinely used as a secondary

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[72] *Ibid.*

[73] Robert Mason Lee, *Death and Deliverance…*, 75.

[74] Department of National Defence, *Annual Report of the Chief of the Defence Staff 2002-2003: A Time for Transformation* (Ottawa: DND Canada, 2003), 13.

SAR resource), and a "Joint Information and Intelligence Capability."[75] Specifically, it does not call for the "transformation" of the SAR system, despite a significant lack of capability in the SAR fleet of modern sensor technologies. The need for transformation of the other monitoring capabilities is certainly justified, but it appears there is a neglect of similar needs in the SAR system, for which the Canadian Forces is also liable.

Perhaps the biggest deficiency, then, is not the failure within DND to administer the progressive development of search and rescue requirements, but rather the political inability to fund directed defence tasks. The federal government might not recognize it, but the famous Clausewitzian dictum that "War is merely the continuation of policy by other means" even has some bearing here.[76] Consider the following quote from Robert Mason Lee, commenting on the failure of the federal Cabinet to adequately invest in modernizing the search and rescue system:

> War, von Clausewitz suggested, is the pursuit of politics by other means; the Canadian Cabinet has broadened that dictum to include the pursuit of patronage. The federal Cabinet is not interested in articulating the role and policy objectives of the Canadian Forces, but it is keenly interested in getting its hands on all that loot.[77]

For a popular writer, Lee has an acute appreciation of defence planning failings within the Canadian federal government. Note that that was written in 1992, twelve years before the current sponsorship scandal came to light. Lee goes on to describe the lamentable state of defence procurement in Canada, in particular how political self-interest undermines the proper funding of search and rescue requirements for SAR Techs:

> Whether the contract is to service a fleet of CF18 fighters or to build a new fleet of frigates, the Cabinet tends to make the decision as

[75] *Ibid*, 21.
[76] Carl von Clausewitz, *On War*, trans. and ed. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), 87.
[77] Robert Mason Lee, *Death and Deliverance*…, 74.

> inefficient and corrupt as legally possible. In the face of such political stakes, the needs of a few SAR Techs are easily overlooked.[78]

If that perception of an ineffective government procurement practice pertaining to the Canadian Forces' requirements was true then, things certainly have not changed as of 2004, given the following assessment: "Critics have decried it as slow, unfair, unaccountable, corrupt and rife with political and bureaucratic patronage."[79]

This sentiment is expressed by Richard Gimblett, in his description of the ten principles of the Canadian way of war. He contends that one of these principles is: "Defence budgets are determined by socio-political not military imperatives."[80] He goes to elaborate,

> The rhetoric of zero-based budgeting theoretically should allow priority funding of clearly identified capability gaps. The reality is that inevitably those are a relatively low consideration (even in eras of budgetary surpluses) amongst an amalgam of national unity social policies, regional development, and other factors in determining military spending.[81]

Therefore, funding the sensor deficiency within the SAR system may prove difficult to achieve.

OPTIONS

Whether or not the current captivation with the word "transform" outlasts its fad phase in the project world, the deficiency issues need to be in the same language. Also, it

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[78] Robert Mason Lee, *Death and Deliverance*…, 75.

[79] Kathryn May, "'Hundreds of Millions' On the Line in Review," *Ottawa Citizen*, 17 March 2004, 1.

[80] Richard Gimblett, "The Canadian Way of War: Experience and Principles," In *Canadian Expeditionary Air Forces*, ed. Allan D. English, 9-20 (Winnipeg: Contemporary Printing, Ltd., 2004), 14.

[81] *Ibid*, 14.

is not simply about the modernization of technology. The introduction of airborne sensors into the search and rescue system, as an embedded resource to be routinely employed in all SAR operations, will necessitate transformational change throughout the process. This will include the blending of new specialist expertise with the traditional MOC manning on the aircraft, new training standards and methodologies, and new performance measurement expectations relating to the primary goal in SAR of preserving lives of those in distress. The entire set of operating procedures, from the expectations of the tasking officer in the JRCC to the aircrew operating the equipment, will undergo some measure of change due to the capability leap that will be engendered in the system.

That is not to suggest that we should abandon the visual search methodology upon the introduction of sensor capabilities. In fact, it would be detrimental and dangerous to do so without ever having proved any concept of sole reliance on a sensor-based search methodology. The argument is that visual searching must be complemented, and augmented by the use of sensors, which will provide an indispensable technological improvement in target detection capability.

Infrared and Electro-optics, along with other electro-magnetic detectors, can be defined as the "field of systems that convert photons to electrons,"[82] Although infrared can be considered an element of electro-optics, these two imaging systems do use slightly different parts of the electromagnetic spectrum. Electro-optic systems more commonly refer to those which read the visible light band, within the spectral region of 0.4-0.7 µm wavelengths. These are known as visible sensors. On the other hand, infrared sensors

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[82] Ronald G. Driggers, Paul Cox, and Timothy Edwards, *Introduction to Infrared and Electro-Optical Systems*…, 1.

read the spectral region of 0.7-14 μm wavelengths.[83] Both systems are subject to obscured visibility due to atmospheric weather such as rain, sleet, fog or pollution, although to different degrees.

The two primary phenomena used to describe the inhibiting effects on visibility are absorption and scattering. Water vapour, carbon dioxide, ozone, nitrous oxide, and carbon monoxide are all factors in radiation absorption. Water droplets, snowflakes, smoke, airborne dust, pollution, and aerosols are all factors in scattering, or the redirection of radiation.[84] The design of sensors can optimize their ability to penetrate to some extent these obscuring phenomena, by using sophisticated computer models to exploit multi-spectral absorption and scattering characteristics.[85] Also, electro-optical systems have better resolution and sensitivity than infrared systems during the day.[86] It is therefore common to find combined IR/EO systems on airborne platforms, and this would be the ideal case for a 24-hour SAR capability as well.

Infrared systems have been around for a long time, but early versions did not have particularly good resolution. Infrared imaging works by passively reading thermal signatures. All objects have some thermal contrast, and with sufficient collection of data in the thermal spectral range, this can be turned into an image. Earlier trials of airborne IR imaging systems for use in SAR proved ineffective due to their limited resolution, but current technological standards provide the requisite resolution and stability characteristics to offer impressive detection capabilities. Improvements in both data collection and digital processing, and the stability of highly magnified fields of view,

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[83] *Ibid*, 1.
[84] *Ibid*, 127.
[85] *Ibid*, 149.
[86] *Ibid*, 96.

have allowed off-the-shelf production of commercial and military IR systems that are affordable and useful for airborne SAR applications. Detection capabilities for broad fields of view and magnified, narrow fields of view are now sufficiently developed and available to contribute substantially to search efforts. After all, the aim of searching is detection, and the market of IR systems now available is perfectly suited to the demands of search and rescue.

The sun is the primary source of light for electro-optic systems, whether by providing direct or ambient light, or of course reflected moonlight.[87] Like IR systems, electro-optics have finally matured to a point of real utility for SAR applications, although earlier versions in the 1980s were inadequate due to limitations in computer processing capabilities.[88] Current systems are useful in daylight, similar to high resolution television, and are also useful in very low ambient light intensities, with Low-Light Level Television (LLTV).[89] Range-gated systems use pulsed illumination, in conjunction with timed shutter openings, to "see" only those returns from beyond a certain distance. Such systems are particularly useful for penetrating through partially obscured weather.

Radar was truly an invention that changed the world, and its broad range of modern applications makes it an indispensable technology, especially for the military.[90]

Weather radar A121eern va(il)Tj0.0064 Tc -0.0221 Tw 12.00121 0 0 12.00121 452.96973 212.21967 T radar systems that are built into weather radars are now also available, that are optimized for basic target detection and mapping of ground features. Synthetic Aperture Radars are particularly powerful tools for searching through cloud and at night, and can be airborne or space based.[91] Such systems are not only effective in penetrating cloud and fog, they can also image broad areas at high resolutions.[92] The US Army found that UAV mounted combinations of Synthetic Aperture Radar and IR/EO systems complemented each other very effectively in tactical applications.[93]

The following table was taken from the Fixed-Wing SAR Statement of Operational Requirement (SOR), 2003, and indicates the detection, recognize and identify ranges (in nautical miles) that are achievable with current off-the-shelf multi-spectral airborne sensors.[94]

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[90] Robert Buderi, *The Invention That Changed the World: How a Small Group of Radar Pioneers Won the Second World War and Launched a Technological Revolution* (New York: Simon and Schuster, 1996), 458.

[91] Tom I. Lukowski, and Francois J. Charbonneau, "Synthetic Aperture Radar and Search and Rescue…, 771.

[92] Mark Hewish, "Lightweight Airborne Radars are Piercing the Battlefield's Veil," *Jane's International Defence Review*, January, 2004: 53.

[93] *Ibid*, 53.

[94] Department of National Defence, *Statement of Operational Requirement: Fixed-Wing Search and Rescue Project* (Ottawa: DND Canada, 2003), 80.

Sensor Capability Requirements			
Scenario	Detect (nm)	Recognize (nm)	Identify (nm)
Maritime – Person (Note 1)	2	1	n/a
Maritime – Vessel (Note 2)	10	6	4
Arctic – Person	3	2	n/a
Arctic – Aircraft Wreckage (Note 3)	10	5	2
Forested – Person	2	1	n/a
Forested – Aircraft Wreckage	7	4	2

Table 2 - Sensor Capability Requirements

Note 1: It is assumed that the person in the water is not wearing any reflective tape or special clothing to aid SAR personnel and that the head and the upper body (waist up) are above water (i.e.- the person is holding on to a floating object). The temperature contrast is assumed to be at least 10 degrees Celsius.

Note 2: The vessel is assumed to be 5m in length and 2m in height.

Note 3: The wreckage is assumed to have a temperature contrast with the background of a minimum of 5 degrees Celsius and a size of at least 1 m^2 (i.e.- not covered with snow).[95]

When compared to the very narrow search track that is used for low altitude, visual searching, there is a clear advantage in a number of these indicated detection and identification ranges available from sensors. More importantly, longer-range detection of potential search targets will direct, or cue, further investigation immediately on potential targets of interest. This is more effective than full-scale visual sweeps of broad areas with multiple, narrow tracks, hoping to detect search targets when directly overhead by happenstance. A SAR aircraft could literally fly most of a long day's search pattern in monotonous grids, finding the crash site only after hours of wasted effort.

In contrast, the improved likelihood of detecting potential targets with the onboard sensor suite would allow more efficient focusing of directed effort. In addition,

[95] *Ibid*, 80.

the longer-range likelihood of detection with sensors means that it is more probable that a crash site that falls outside the planned search area will be noticed and investigated. This is highly improbable in the case of visual searching, due to the very localized nature of visual search tracks. Thus, missing aircraft that are unlucky enough to fall in the percentage of cases outside the pre-planned search area, would never be found in a visual search, whereas they may be detected by sensor capabilities.

Although great advances have been made in developing remote sensing technology for satellite and (UAV) applications, there are important reasons why sensors must also be used onboard the primary SAR aircraft that respond to air and marine distress cases in Canada. In the case of satellites, they are very expensive, and have intrinsic bandwidth and weight limitations.[96] Ownership of satellite resources might not be necessary, as imagery could be purchased from available sources, but this would still be subject to coverage limitations. Imaging satellites are not geosynchronous, so coverage for SAR applications requires luck and careful management.

UAVs are capable of carrying impressive sensor packages, but they also have limitations compared to manned aircraft. They rely on data links for functionality, which places the data sensing one link further removed from the decision-making, and the process can be disrupted with system failures. Another drawback is that "they are essentially fair-weather systems with limited range and speed."[97] Future generations of UAVs may be able to contribute more robustly to SAR operations, but currently they would be unable to effect a rescue. One advantage, however, would be their

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[96] Andrew G.B. Vallance, "Force Multipliers: Combat-Support Air Operations," *The Air Weapon: Doctrines of Air Power Strategy and Operational Art* (New York: St. Martin's Press, 1996), 18.

[97] *Ibid*, 19.

complementing presence, with sufficient range and endurance to contribute effectively to search operations, augmenting other resources.

In SAR, the survival of distress victims relies on timely decision-making based on local circumstances. Sensor-derived information relating to rescue actions in difficult terrain and weather conditions is best managed by the crew at the scene. This is a good example of the well-tested tenet of air power, centralized control and de-centralized execution:

> It also allows air action to be refocused quickly to exploit fleeting opportunities, respond to the changing demands of the operational situation and be concentrated at a critical place and time to achieve decisive results.[98]

It is for these reasons that, "manned aircraft are well suited to specialized missions and remain the most efficient platform for a number of applications."[99]

There are a number of other uses for these airborne technologies, such as maritime surveillance, C4ISR, and police surveillance, not to mention commercial applications. Within the CF, there are a number of active airborne sensor projects that indicate the SAR system is lagging behind in comparison. These include the Aurora Incremental Modernization Project, the CF18 Incremental Modernization Project, and the Maritime Helicopter Project. These all have some level of sensor technologies that are being upgraded, as opposed to the dearth of such systems in the primary rescue fleet. The SAR system may be devoid of airborne sensors, but it is certain the navy would never accept the same deficiency in the maritime helicopters. It is too vital to the security of the naval fleet.

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[98] Department of National Defence, *Out of the Sun*…, 38.

[99] Andrew G.B. Vallance, "Force Multipliers: Combat-Support Air Operations," *The Air Weapon*…, 19.

Some current efforts are being made to address the SAR deficiency. There is a trial project to determine concept feasibility for a Rapid Mount Airborne Sensor (RMAS) system on the CC130 Hercules. This proof-of-concept trial will allow any generic IR/EO detectors to be installed in a pod mounted at the side parachute door of the CC130 Hercules. If successful in proving its viability, this project will help develop many procedural requirements for the introduction of sensors into primary search and rescue, and should also generate increased support for the idea.[100] The RMAS project is technically limited, however, in that it cannot integrate sensor data through the cockpit avionics for use by the pilots. The Fixed-Wing SAR project, on the other hand, does have some very robust requirements for an integral sensor suite. This aircraft is intended to replace the CC115 Buffalo and the CC130 Hercules in the search and rescue role across Canada, so it would provide a national SAR sensor capability if successful.[101] It would be a large step in the right direction, but support for funding such a large capital project will be critical if it is to become the first comprehensive sensor suite employed in primary SAR.

There are of course a number of difficulties in converting to a sensor-equipped fleet. Training and operating standards for the aircrew would be necessary. The extent to which sensor information is integrated into the aircraft avionics will determine both utility and cost. The integration of such data through the Flight Management System (FMS) would also have to satisfy stringent certification standards, so choices must be made regarding the associated control and display of sensor information. In the case of

[100] Department of National Defence, *Statement of Operational Requirement: Rapid Mount Airborne Sensor (RMAS) System* (Ottawa: DND Canada, 2000), 3.

[101] Department of National Defence, *Statement of Operational Requirement: Fixed-Wing Search and Rescue*…, 11.

fixed-wing aircraft, there is a requirement to be able to land on gravel runways when conducting SAR operations in northern Canada. This requires engineering design solutions for externally mounted sensors that can withstand the rigour of Canadian SAR flying operations. All these questions are surmountable, but require appropriate analysis and project support to succeed.

In the United States, the US Coast Guard's Deepwater project may provide lessons learned for a Canadian sensor capable SAR system.[102] The US Coast Guard is responsible both for search and rescue, and maritime surveillance as a component of national security. This may prove to be an ideal model for the Canadian SAR system to eventually emulate.

The risks for the aircrew of SAR flying operations have already been discussed. There is a methodology of using risk decision models for such operations, but it is not very practical for SAR operations. Such models use a decision matrix in an attempt to measure the degree of risk beforehand, allowing the aircrew to decide whether or not to accept the mission.[103] However, those decisions are very difficult to make when others' lives are already at risk, and so the SAR crew's decisions will inevitably favour mission acceptance. It is therefore important to properly mitigate the risk by applying suitable modern technological enablers instead. This is one advantage of airborne sensor systems in search and rescue.

Canada actually has a healthy and viable research focus on sensor technologies, through Defence Research and Development Canada (DRDC), whose Research and

[102] United States, United States Coast Guard, *Deepwater Capabilities Project: Mission Need Statement* (Washington, D.C.: May 3, 1996), 2.

[103] Department of National Defence, *1 Canadian Air Division (1 CAD) Orders: Volume 1 Annex A* (Winnipeg: November 30, 1999), A1/3.

Technologies motto is "Innovation for Canada's Defence."[104] Unfortunately, the government's modernization goals are focused elsewhere, at the expense of opportunities to invest in airborne sensor technologies for search and rescue. In 2000, the Deputy Minister of National Defence and the CDS published their modernization plan for the Canadian Forces. It listed as an objective the generation of "advanced combat capabilities that target leading edge doctrine and technologies relevant to the battlespace of the 21st century."[105] It then lists as a five-year target to achieve this: "Re-focus defence R&D on the operational needs of the department capitalizing on leading edge technologies, while exploiting Canadian technical expertise, especially in the areas of space, remote sensing, telecommunications and information management."[106] If this has happened, however, it is not evident in the SAR system.

One unheralded benefit of having sensor capabilities in the SAR fleets would be the potential public relations advantage of having recorded media, including video of rescues. It would be difficult to evaluate its utility qualitatively, but the value of providing newsworthy coverage of events should not be under-estimated. In fact, given the amount of effort expended by DND in public affairs, the ability to allow Canadians to observe search and rescue and other activities of potential interest to the CF may be an invaluable and enormously popular benefit. The ability to record events with electro-optic, or even infrared systems, means that such imagery could be provided to the media with newsworthy timeliness. In addition to SAR coverage, imagery could also be useful

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[104] Defence Research and Development Canada website: available from http://www.drdc-rddc.dnd.ca/researchtech/rdprogram_e.asp; Internet; accessed 17 March 2004.

[105] Department of National Defence, *Shaping the Future of the Canadian Forces: A Strategy for 2020* (Ottawa: DND Canada, 1999), 9.

[106] *Ibid*, 9.

for many other cases, such as illegal immigration vessels, pollution, and fishing violations.

It must be considered that, firstly, search and rescue operations are some of the most demanding activities conducted by the Air Force, despite their peacetime nature. Secondly, SAR incidents comprise incredible human interest stories in their own right, which in today's television dominated attention for news, are usually inadequately covered due to the lack of available source material. Anyone who has seen coverage of SAR incidents on television news can picture the talking head, with a file photo of a yellow helicopter in the background. It simply does not have the same impact, especially to a visually cued audience thirsty for some positive coverage of the Defence Department, as does real video. Thirdly, the remoteness of most SAR operations means that there is no other means for the media to cover the story. The lonely airplane or helicopter, flown by dedicated crews who have searched through the night for twelve hours without sleep, will be the only possible source of information when survivors are found at a crash site. This kind of coverage is absolutely irreplaceable.

There is another aspect to potential sovereignty applications with a sensor capable SAR fleet. Consider the seemingly odd Elections Canada declaration that our federal electoral boundaries now extend to the North Pole, despite the fact that there is no feasible means of administering election activities over most of this region. The stated reason for this, given by a Canadian Natural Resources Department spokesman, was "…to clearly show the ownership of the North to the world."[107] The supposed use of electoral boundary designations, in the interest of exerting sovereignty declarations,

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[107] Tim Naumetz, "New Federal Ridings Reach All the Way to Santa's Workshop," *Ottawa Citizen*, 14 March 2004, 2.

perhaps shows just how desperately inadequate Canada's efforts to date have been. The CP140 Aurora has been Canada's primary means of exerting sovereignty claims over arctic regions by the use of overflight patrols, but there is a looming deficiency in its future availability. This is likely, even though it may well be argued that the current standard of overflight presence already falls woefully short of the need. The current Hans Island dispute between Canada and Denmark may prove to be a case in point.

Unfortunately, the application of cost savings in the Aurora's flying rate completely undermines the intent of sovereignty patrols, which is airborne presence. A lesser actual presence of Canadian military aircraft in the arctic of course weakens both the sovereignty claims due to presence, and any realistic chance of observing either sovereignty violations or other activities of interest to the federal government. In addition, it is not only the need to observe such activity, but also the need to record it, that is of importance. The Aurora aircraft is well suited to such patrols not only because of its long range flying characteristics, but also because of its capability to observe and record events of interest. There are a lot of activities of interest that require monitoring, as well as recording for legal prosecution in some cases. These include terrorists, oil spills and other environmental impacts, oil and mineral exploration rights, and control of fishing. This is where the modernization of the search and rescue fleet with airborne sensor capabilities could be of potential utility, beyond the role of primary search and rescue. The SAR fleet, in its routine conduct of training and operations, by default travels within and beyond the limits of Canada's territorial boundaries. This is because Canada's international area of SAR responsibility overlaps by a significant margin the territorial sovereignty areas of interest. This means that SAR aircraft could also be used to cover such areas of territorial sovereignty interest, thereby exploiting both their capabilities and readiness posture.

The federal government has stated its intention to improve the surveillance of Canadian waters, increasing the level of maritime security, which would be prudent for a country with the longest coastline in the world. This would in part be due to improved information sharing between those responsible for monitoring the presence of foreign vessels in our territorial waters. This includes the Navy, as well as the Coast Guard within the Department of Fisheries and Oceans. However, this objective is notably undermined by the fact that "…the Air Force has had to cut its number of coastal surveillance patrols because it does not have enough money or aircraft."[108] This is precisely the kind of opportunity where the inherent surveillance capabilities of a properly equipped SAR fleet of aircraft could contribute to national security aims, thereby utilizing the sensor systems of SAR aircraft to mitigate our otherwise reduced airborne presence.

It is true that the search and rescue capability of the SAR fleet is more important than the security monitoring it could contribute in the same regions, but the argument to be made is that the use of these resources should be more optimized. The SAR fleet already has a presence geographically where it could contribute to coastal monitoring activities, especially at a time when we are doing it insufficiently with other available resources. However, the SAR aircraft could only contribute meaningfully to the monitoring role if they are adequately equipped with airborne imaging capabilities.

[108] David Pugliese, "Government Vows Better Coastal Security, But Holds Back Funds Pending Review," *Ottawa Citizen*, 16 March 2004, 1.

Such use of search and rescue aircraft may in future complement the restrictive employment of other, more traditional assets for sovereignty overflights of northern Canada, such as the Aurora. As has been demonstrated by the funding realities of the last decade, these are exactly the kinds of financial efficiencies that DND needs to strive for, given the current nature of the CF's resource starved environment. Sovereignty patrols may not in fact be a sufficient legal declaration of national control of territory, but they constitute at least a minimum level of effort in an otherwise untended North. The clincher, of course, is that there is no point in going if you cannot observe, and record, such activities as are the objects of monitoring. The availability of capable, sensor equipped SAR aircraft would augment substantially the federal government's otherwise limited options in both monitoring and declaring sovereignty over what constitutes the vast majority of Canada's geopolitical territory.

OPERATIONAL/COST BENEFITS

Even though there can be individual cases where SAR capitalization receives some priority consideration within the department, there has been a disconnected effort in the pursuit of airborne sensors for the primary search and rescue fleets. Despite the primacy of operations accorded to SAR in the Air Force, the investment in airborne sensor systems is overwhelmingly resident in the aircraft that are used as secondary SAR assets, and is practically void in the primary SAR aircraft fleets.

A failure to develop and maintain robust surveillance and detection capabilities will have future ramifications, and this is a role to which the SAR fleet could contribute.

The Future Security Environment is too unpredictable to sell ourselves short of capabilities we are not even aware that we will need. The United States, the United Kingdom and Canada have all analyzed possible ramifications of future threats, and the common consensus is a need to focus on preparedness for uncertainty. According to the American assessment of the Future Operational Environment, "history suggests that it is only a matter of time until an adaptive, creative opponent develops a method of war that will attempt to defeat America's established, generally predictable preoccupation with the science of war and the application of precision firepower."[109]

The British perspective refers to, amongst a host of other concerns, the "increased destructive power of the asymmetric threat from terrorists", as well as greater inter-state migration and increased competition for scarcer natural resources.[110] These three concerns in particular have obvious surveillance and monitoring implications in Canada's circumstances.

DND's analysis of the Future Security Environment states emphatically that "The future is uncertain", which is the entire point, although it is really not a surprise.[111] The report also cites environmental degradation, resource depletion, mass migrations of displaced persons, and a possible increase in terrorism as future threats to stability.[112] Its tone seems less alarmist than the US and UK perspectives, as far as terrorism is concerned. Nonetheless, it does admit that, "It may be difficult to accept, but there is a

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[109] United States, United States Joint Forces Command, *The Future Operational Environment: The World Through 2020 and Beyond* (Washington, D.C.: 7 August 2003), 115.

[110] United Kingdom, Joint Doctrine and Concepts Centre, *Strategic Trends: Methodology, Key Findings and Shocks* (Shrivenham: March, 2003), 1-10.

[111] Department of National Defence, *DOR(CORP) Project Report PR 2003/14: Future Security Environment 2025* (Ottawa: DND Canada, 2003), 49.

[112] *Ibid*, 32.

genuine possibility that the world of 2025 will be a much more dangerous place than it is today."[113]

Our lack of coastal surveillance capability is well documented. A Canadian Senate committee report has identified significant shortfalls in Canada's coastal surveillance capabilities, in light of current and developing threats.[114] The report, titled *Canada's Coastlines: The Longest Under-Defended Borders in the World*, adopts a rather alarmist tone, explaining that it is important as a wake-up call to Canadians to engage them more seriously in security concerns.[115] Citing a pending decline in available flying hours by the Aurora patrol aircraft, it states: "We have no standing naval patrols on either coast that are capable of keeping watch over our maritime littoral…The Canadian Air Force lacks the resources for aerial reconnaissance over any of our major ocean and sea going areas."[116] It then goes on to state that the Aurora patrol aircraft "…are functioning with obsolete sensor systems and without the latest technology."[117] There is evidently a need to correct the lack of surveillance attention to Canada's coasts, in our own continental security interest, and this is a capability area where sensor-capable SAR aircraft could contribute.

As long as the CF is committed to the provision of a 24 hour per day, immediate readiness SAR service for Canadians, it only makes sense to optimize the potential use of this already costly resource, by contributing more effectively not only to saving lives, but also to securing Canada's national interests in the current and approachthis 1 0 0h .8tf al use e. s uncertainty. The chart previously referred to, which listed the achievable detection capabilities with current generation systems, indicates how far we could go to improve the search capabilities in the SAR system. Unfortunately, departmental history indicates that, simply because the FWSAR project analysis of SAR needs has produced a capability requirement, it does not necessarily mean it will be funded. In 1994, the Defence White Paper prompted a new and illogical approach to defence procurement, during the height of budgetary cutback pressures, by stating that, "The Department will also explore innovative ways to acquire and maintain equipment."[118] That kind of unfortunate direction led to confused expectations of what could be gained by not paying for it, and eventually it also led to the political death of the Future Strategic Airlift project. Despite attempts to appease government demands with business case analyses, in this case airlift aircraft which comprised one of the defence department's highest capability deficiency priorities, the project was cancelled outright. This was "not particularly surprising given DND's highly stressed fiscal environment."[119] The attempt to explore innovative financing solutions for strategic airlift, of course, produced nothing.

It appears that the senior leadership in the CF is stuck in one of the unenvied corners of Pigeau and McCann's leadership model.[120] According to these researchers, having all the responsibility but none of the authority makes for ineffectual leadership, and failed attempts within the CF to satisfy government policy through capabilities-based planning surely fits this mold. Douglas Bland criticizes this political/military disconnect

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[118] Department of National Defence, *1994 Defence White Paper* (Ottawa: Canada Communications Group, 1994), 41.

[119] Martin Shadwick, "The Strategic Airlift Enigma," *Canadian Military Journal* (Summer 2003): 63.

[120] Ross Pigeau, and Carol McCann, "Re-Conceptualizing Command and Control," *Canadian Military Journal*, (Spring 2002): 60.

when he states: "National defence policies can never be sustained if they are simply declarations made by governments."[121] Or, as Pigeau and McCann state, "…although responsibility has been taken, power over resources has not been assigned or no clear mandate to act has been authorized."[122] This concisely describes the procurement impotence within DND. It is time to stop using the tired old analogy of thinking outside the box, and instead, in this particular case, simply move within the Pigeau and McCann box from the "ineffectual" corner to one that works. All this searching for "innovative financing" solutions for DND's funding woes, against the ironic backdrop of unprecedented federal surpluses, is incongruous. If by innovative financing, the government means "something for nothing", it is not going to get it. As always, *caveat emptor*. In the end, you get what you pay for, and a serious investment in sensor capabilities to modernize and transform Canada's search and rescue system must be made.

Regarding operational efficiencies, the benefits of reduced search times are threefold. First, the likelihood of saving lives increases, since it is especially critical to locate and render assistance to crash victims as soon as possible, ideally within the first "Golden Hour" of survival, although this will not always be possible. Secondly, the cost of strictly providing SAR service is reduced due to the decrease in flying hours. Thirdly, such economies of savings in the utilization of primary SAR resources frees them up for other roles, which optimizes the use of these multi-role capable assets, in a demanding but under-funded security environment.

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[121] Douglas L. Bland, "Finding National Defence Policy in 2004," *Canadian Military Journal* (Winter 2003-2004): 3.

[122] *Ibid*, 60.

The survival advantage of earlier detection of distress victims as a result of airborne sensor capabilities is essential. All victims of distress will be medically subject to shock, especially if they are seriously injured. In such cases, they must have the will to fight the "seven enemies of survival: pain, cold, thirst, hunger, fatigue, boredom and loneliness."[123] SAR Techs continually stress the need to find crash victims as early as possible, to better mitigate such threats to life. Canadian air doctrine stresses that "the possibility of survival and recovery decreases rapidly with time, particularly if survivors are injured."[124] This is the most important reason to improve detection probabilities with sensor technology.

To illustrate the potential advantages of onboard sensor capabilities, consider the following example. A CC130 SAR crew is called to respond to a case of an aircraft over the ocean, which has issued a distress radio call due to engine failure. When the CC130 arrives, an ELT signal pinpoints the location, but all that remains are a missing aircraft and a number of people floating in the water. Even if there were no ELT, an infrared system could cue the search aircraft to possible targets within the general area. It is dark, with no helicopter or ship available for several hours. The surface temperature of the water is cold enough that survivors will not last beyond one hour before succumbing to hypothermia.

There are two things the rescue aircraft can do to help – drop twenty-man liferafts into the water, and have the two SAR Techs parachute into the water to help. In both cases, very precise information is needed regarding the location of the survivors, especially since hypothermic victims are incapable of swimming toward the liferafts. In

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[123] Department of National Defence, B-GA-217-001/PT-001 *Down But Not Out* (Ottawa: Supply and Services Canada, 1984), 12.

this case, it is possible that the only means of saving them would be with an infrared system sensitive enough to detect the people in the water, and also integrated into the avionics displays to allow the pilots to fly a sufficiently precise low altitude pattern to release the liferafts over the survivors.

In another instance, consider that the Hercules responds to an ELT signal over land, but that the visibility is partially obscured due to weather. In that case, if the aircrew cannot see the ground clearly themselves, there is nothing they can do. This is a fairly frequent occurrence in search and rescue, and in isolated locations there will not likely be any roads to send help otherwise. If there are survivors at that site, and they are unable to communicate by radio, they will literally have to wait however long it takes for the weather to clear. On the other hand, if the SAR aircraft has a range-gated EO system capable of piercing the obscuring weather, sufficient detail could be gained to drop a radio at the identified location of the crash site, determine the medical status of survivors via the radio, and order a helicopter to retrieve them. It is therefore evident that such sensor capabilities can contribute both to the direct rescue effort, and to faster resolution of the reported distress case, depending on circumstances.

The overall cost of the provision of SAR services through the Air Force is impossible to determine, because the funding for both SAR and other core military functions is not distinct. Infrastructure, administration, fuel, personnel and other costs at air force wings are generally blended into the overall operation of the wing, and the identification of costs resulting from the SAR system cannot be made. There is one area of hard data, however, that gives an indication of the expense of this service. Every

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[124] Department of National Defence, *Out of the Sun*…, 110.

flying hour of every aircraft in SAR operations and training is logged, and these flying hours can be referenced to the very strictly analyzed direct aircraft costs.

The following chart indicates the cost per flying hour of each of the aircraft the Canadian Forces currently uses in the primary SAR role.[125] It does not include aircraft that are also routinely tasked as secondary SAR assets, like the CP140 Aurora and CH124 Sea King helicopter.

Aircraft Costs – Rates Per Flying Hour – FY 2003-2004$			
Fixed-Wing Aircraft	**SAR Location**	**Avg Flying Hours /craft/yr**	**Full Cost per hour**
CC115 Buffalo	Comox	406	$11,145
CC130 Hercules	Winnipeg, Trenton, Greenwood	656	$14,736
Helicopters			
CH113 Labrador	Trenton	296	$10,958
CH 149 Cormorant	Comox, Greenwood, Gander	393	$10,574

Table 3 - Full Aircraft Cost Per Flying Hour – Primary SAR Aircraft

For example, the CC130 Hercules costs DND $14,736 per hour to operate, including all applicable costs, such as fuel, aircrew salaries, maintenance and depreciation. It is clear that these flying operations are inherently expensive. The direct cost of fourteen hours flying time, which is the regulated daily maximum, for a search by a CC130 Hercules, is over $206,000.[126] When it is considered that most search efforts that are initially unresolved expand into larger searches involving more than one aircraft, the total costs rapidly escalate. It is not unusual, then, for the cost of major search efforts for missing

[125] Department of National Defence, *Cost Factors Manual: 2003-2004* (Ottawa: DND Canada, 2003), 3-1-1, 3-1-2.

[126] Department of National Defence, *1 Canadian Air Division (1 CAD) Orders: Volume 2 Flying Orders* (Winnipeg: November 30, 1999), F1/2.

aircraft and vessels to rapidly exceed $1 million. The reduction in search times would gain obvious efficiencies in the cost of conducting SAR operations.

Because the SAR system responds to so many false alarms, it is obvious that a reduction in such cases would also reduce the cost of SAR operations considerably. Unfortunately, pending more rigorous legislation that would compel greater reliability in ELT systems and more restrictively safe behaviour on the part of operators of aircraft and vessels, such rates of false alarms are unlikely to change. Hence, there is no practical choice in the SAR system but to investigate each incident report as a genuine distress case, as the outcome is always indeterminate until SAR resources resolve the case. For example, there may be only one case in twenty where an ELT signal leads to injured survivors in need of rescue, but if a rescue capable SAR aircraft does not arrive each time, they will not likely be saved.

The SAR aircraft themselves are not only costly to operate, they also constitute a relatively scarce resource. The average flying hours per aircraft per year, as indicated in the above table, show that there is not an abundance of flying activity to spare. Therefore, each reduction in flying time afforded by the use of airborne sensors in SAR will increase the availability of those aircraft for other roles. Because of the multi-role capability improvement, the advent of a sensor suite may also increase demand for the utility of the SAR fleet in other surveillance roles. The starvation of other Air Force capabilities will make such multi-role optimization even more critical.

CONCLUSION

In conclusion, it is clear that to date there has been a lack of investment by the Canadian Forces in implementing airborne sensor technology in the primary search and rescue fleet of aircraft. This has been true of the older aircraft types such as the CC115 Buffalo, CH113 Labrador, and the CC130 Hercules, and it remains largely true for the introduction of the latest primary search and rescue asset, the much fought over acquisition of the CH149 Cormorant, otherwise known as the highly contentious EH 101 "Cadillac" helicopter. With the exception of a low-grade search radar capability built into its weather radar system, the Cormorant is as devoid of modern sensor technologies as is the ancient Buffalo. It will also remain true until the FWSAR project spends its first dollar on sensor equipment, which is not guaranteed given the past record of capital project successes within DND.

This will prove to be an untenable situation in the near future, unless efforts are made to correct the near term deficiencies in this capability area. As has been shown, it is incumbent upon DND, and the federal government ultimately, to provide a level of SAR service to the Canadian public that will attempt to meet their by now fully entrenched expectations regarding the search and rescue system. It is not only a matter of expectations, however, it is also the correct approach in maintaining the SAR system at a reasonable level of technological competence. Failure to modernize this aspect of the SAR system will impose liability concerns. Although governments may in fact fear the liability of electoral attention more than the legal form, the point is still made.

Imprudence will only mean more lives lost as a result of the inadequate system that is meant to save them.

Fortunately, small steps have been taken in a couple of key areas to proceed with more robust intentions for future SAR capability. The ongoing electro-optic and infrared imaging systems being developed for the CC130, known as RMAS, should provide some critical expertise in the operational community in the use and maintenance of such systems, although the project itself is conducted as a trial.[127] The advent of this kind of technological change into long standing operating procedures will need some time to develop and mature, and the CF, or at least the SAR capability component of the CF, is rather late in making the attempt.

Another positive sign is the requirement for an integral sensor suite embedded in the Statement of Operational Requirements for the new Fixed-Wing SAR Aircraft Replacement project. It is a good start, and if successful will provide the SAR system with its only fully capable primary SAR asset that has a comprehensive sensor system incorporated into its concept of operations. There are pitfalls of course in gaining the requisite funding approvals, as the competition for SAR capital within the difficult Canadian defence procurement process is severe, as has been demonstrated.

Less time spent flying at low altitudes, in poor weather, and close to their stall speeds while conducting truly ineffective search operations, will also substantially mitigate the risks assumed by the SAR crews themselves. Flying is a dangerous business, hence the amount of demand for SAR operations, and conditions can be just as dangerous for SAR crews, their professional ability to make life and death risk management

[127] Department of National Defence, *Statement of Operational Requirement: Rapid Mount Airborne Sensor (RMAS) System…*, 3.

decisions notwithstanding. Examples were cited of the loss of search and rescue aircraft in the course of duty, due to exactly these kinds of operational risks, and from a purely business case analysis perspective the cost of risk-mitigating sensor technologies may well pay for themselves in the reduced attrition of SAR aircraft.

Finally, despite some of the inevitable difficulties in adopting such systems, it is necessary to consider possible expanded future applications of an integral sensor suite for the primary search and rescue aircraft fleets. Increasing financial pressures driving toward multi-role capabilities will make the potential expansion of SAR airborne sensor capabilities attractive. Such applications would range from sovereignty patrol capabilities, with the ability to record information of monitoring interest for legal prosecution, to the simple but powerful production of real-time newsworthy coverage of some of the Canadian Forces' most interesting but rarely witnessed accomplishments.

The ultimate advantage, however, will be the capability improvement in the primary goal of rescuing people from distress, as a result of Air Force investments in airborne sensing SAR capabilities. The improvements in all-weather capability in the provision of SAR service to Canadians, along with dramatically increased probabilities of detection in some cases, will lead to more timely and more frequent possibilities for saving lives.

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